READABLE BOOKS: ANIMAL LIFE

THREADS IN THE WEB OF LIFE

BY

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Readable Books in Natural Knowledge

THREADS IN THE WEB OF LIFE

natural prey of the lion is becoming scarce, the domesticated animals suffer very seriously. We are told that the first colonising of Mashonaland was made extremely difficult because of the havoc wrought by lions among horses, cattle, sheep, and goats. Old lions that are no longer able to bring down the larger wild animals easily, sometimes make their lair in the neighbourhood of villages and prey upon the flocks and herds belonging to the people. They will even lie in wait by the drinking places and carry off women and children who come for water; and stories are told of their snatching children at play in the villages themselves.

At night a hungry lion will not hesitate to attack a man, and we read that, when the Uganda railway was in course of construction, the coolies were in deadly terror because of two man-eating lions that had taken up their quarters in the neighbourhood, and made frequent raids on the camp. The lions were shot, but not until they had carried off "twenty-nine Indian coolies and an unknown number of African natives."

The tiger is even larger than the lion, and it is much more cunning. It is cautious, too, if not indeed cowardly; for it never attacks an armed man, though the helpless unarmed Indian natives and women and children often fall victims to it.

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PUBLISHERS' NOTE

So much attention is now given to the practical and systematic study of science in schools, that the valuable influence of descriptive scientific literature is apt to be overlooked. An intimate knowledge of the simplest fact in Nature can be obtained only by personal observation or experiment in the open air or the laboratory, but broad views of scientific thought and progress are secured best from books in which the methods and results of investigation are stated in language which is simple without being childish.

Books intended to promote interest in science must differ completely from laboratory guides, text-books, or works of reference. They should aim at exalting the scientific spirit which leads men to devote their lives to the advancement of natural knowledge, and at showing how the human race eventually reaps the benefit of such research. Inspiration rather than information should be the keynote; and the execution should awaken in the

reader not only appreciation of the scientific method of study and spirit of self-sacrifice, but also a desire to emulate the lives of men whose labours have brought the knowledge of Nature to its present position.

These are the objects of the series of Readable Books in Natural Knowledge to which the present volume belongs. Each volume will endeavour to stimulate interest in the studies with which it is concerned, and to present natural phenomena and laws broadly and attractively. It is hoped that the books will provide the reading matter urgently required in connection with the science work in schools and will appeal also to a wide circle of other readers. The series should be of service in directing attention to the nobility of scientific ideals and the ultimate value of results obtained by careful and faithful work.

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CHAPTER I

MAN AS HUNTER

If we examine a piece of finely-woven cloth, pulling a little bit of it to pieces, we shall see that it is made up of many different threads, some running lengthwise and others worked in and out across these in a regular and orderly manner. If we look a little closer still, we shall see that each thread is made up of several different strands closely twisted together, and we cannot pull out a single thread, or even a single strand, without distorting and spoiling the whole fabric.

This is a fit emblem of the way in which all living things are interwoven and intertwined to form one great, well-balanced whole. The web of life is indeed much less simple than the web of cloth. There are innumerable threads in it, and each thread is made up of innumerable strands. The pattern is so intricate that sometimes we can hardly see it at all. We see separate threads or

strands and we follow them for a little way, but we soon lose sight of them in the maze. We may even ruthlessly displace some of them and not see any bad results at the time. But if we look at life thoughtfully, we can make out part of the web for ourselves. Much more has been revealed to us by the patient labours of many naturalists, and it is now quite certain that every living thing has its own proper place and influence, and that no life, whether of man, or beast, or plant, can be lived unto itself alone, and none, however lowly, can be destroyed without affecting many others.

It is easy enough to realise, if we look round about us, how one human life is bound up with another. The helpless baby in its mother's arms would die but for her constant care; the older child is still wholly dependent on its parents; the boy who goes to school soon learns that he must take his place as part of a whole, that his own wishes must often give way to the will of others, that in lessons he must strive to keep pace with his fellows, that in games he must do his best at the particular post assigned to him.

As he grows older and has to decide what his share in the world's work is to be, he should ask himself, not merely, What should I like to do? nor even, What can I do best? but, What can I do that others have need of? Having chosen his work,

he associates himself with others of the same occupation, who have framed for themselves laws which bind them to act, not each for his own advantage, but all for the good of all. In the same way he has his duties towards his city and towards the State, and he has a right also to a voice in the government of both.

But the web of life means more than this. It is not with the lives of his fellows alone that the life of man is intertwined; it is as closely and even more inevitably bound up with the life of animals and plants. Some of the inter-relations are easy to see, though they are not the less interesting on that account; but others lie deeper, and it has required years of patient study to make them plain.

Let us begin with the simplest of these relations, and try to understand better and more clearly the intricacies of the web.

Life nowadays is not a simple thing, and man's wants are many, but if we ask what his real *needs* are, we shall find that they are only two—food for himself and his children, and shelter from the cold and from the heat. For the supplying of these needs he is wholly dependent on the animal and plant world.

The simplest way of procuring food is by killing what animals are available, or gathering what fruits can be found. The earliest relation between man

and animals, therefore, was that of hunter and hunted. The men of a tribe, in the early days of mankind, were all huntsmen, and the most successful huntsman among them was the most highly honoured. When food was needed the strong men of a tribe set forth on an expedition, and when they returned, if their hunt had been successful, they were welcomed with joy by those who had remained at home. Songs were sung in their honour, and there was much dancing and feasting. If the tribe was at peace with its neighbours, the "braves" spent their time between expeditions in resting, and in meeting together and holding long, long councils; for war and hunting were their only duties. Everything else was left to the women, helped by the boys not old enough to hunt.

There are still tribes in many parts of the world where the men devote themselves mainly to hunting, but wherever the climate is favourable they have learnt also to grow certain grains, like rice or millet, and to prepare roots such as the manioc, so that they are no longer so entirely dependent for food on what they can kill. But the case is different where the climate is unfavourable and the soil unproductive.

In some regions whole tribes of people depend entirely on a few particular animals, and suffer terribly if, from any cause, they are unable to

procure them for a time. Thus the Eskimos in the Far North depend mainly on seals. The flesh of the seal is their chief food; the fur supplies the whole of their clothing, even to their boots, as well as their bedding and the furnishings of their huts. Their clothing is sewn with needles fashioned out of the seal's smaller bones, and the larger bones are used to make many of their tools. Strips of sealskin form the reins and whips with which to drive the dogs that drag their sledges to the hunting-grounds and bear back the precious load of meat.

FIG. 1.—Eskimo Family.

The dogs are fed with the coarser parts of the seal's flesh, and the "blubber," or oily fat under the skin, is used to fill the lamp which supplies the Eskimo with both light and heat throughout the

long, dark, cold winter. The finer sealskins take the place of money, too, for when a tribe gets far enough south to fall in with travelling traders, these skins can be exchanged for highly prized metal goods, such as weapons and cooking utensils, and for various other luxuries which help to make life less hard.

During the short summer the tribes remove to the mainland, and hunt reindeer, catch salmon in

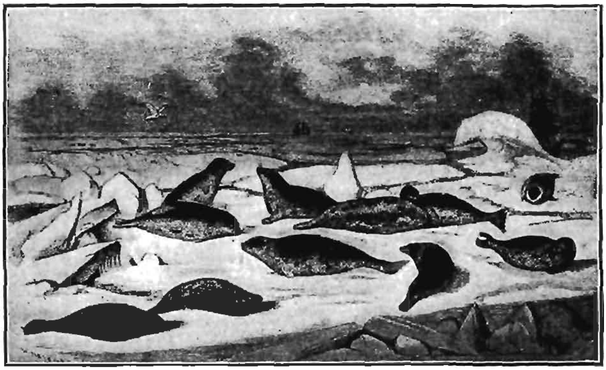


FIG. 2.—Seals among the Ice.

the rivers, and snare sea-birds. But the summer lasts for barely three months, so that for the greater part of the year the Eskimo is dependent for the supplying of his daily wants entirely on the seal. But the seal in its turn must have food, so it follows the shoals of fishes, and if the fish, which again have to go where they find the greatest numbers of the small animals on which they feed,

leave the neighbourhood of a village, the seals, of course, go too. The Eskimo hunters have then to make long journeys across the ice with their sledges to find the seal-holes. If, as sometimes happens, they are unable to find the seals before the stock of dried meat and smoked fish becomes exhausted, the distress in the village may be terrible.

One of Mr. Kipling's wonderful *Jungle Book* stories tells of an Eskimo village in time of scarcity. Three destitute strangers from another tribe had been taken in by the hospitable villagers, who shared with them all that they had. But the seals moved away so far that the huntsmen could not find them, and the stock of food began to give out. The people weakened rapidly, the dogs sickened and died, or went mad and broke away, and soon the whole village lay suffering and silent in the deep darkness and bitter cold, for the blubber had burnt down and the lamps had gone out.

Then a boy, just growing up to manhood, declared that he heard the voices of spirits calling him to go forth and look for the seal. A young girl, one of the stranger tribe, offered to accompany him, and together they set forth, dragging a little hand-sledge on which were packed their hunting gear, a travelling lamp, and the little food that could be spared. For many days the two toiled painfully on, never quite losing hope, for they

believed that they were being guided by the spirits. At last one day, when their minds were growing cloudy and their eyes dim, they saw a strange two-headed thing gambolling in front of them. A gale came on and for three days they crouched in their snow-hut. Then the "Thing" showed itself once more and they followed it without fear or surprise. It guided them straight to the seal-holes. A seal was killed, part of it eaten,

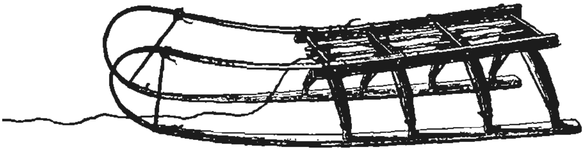


FIG. 3.—Eskimo Dog-Sledge.

part buried, and as much as possible packed on the sledge.

The mysterious thing proved to be two of their own dogs which had broken away with their harness on, when the madness was upon them. They had met and had fought fiercely, till the reins about their necks had become so much entangled that they were unable to tear themselves apart again, even after they had found food and recovered their health of mind and body. Guided by the dogs, the now invigorated boy and girl took a direct line for home, reaching it just in time to save their people from death. The huntsmen of the village, after a

strengthening meal, set out for the seal-holes, and soon the rescued village was a scene of joy and feasting.

In countries a little farther south, and away from the sea-coast, where the winters are not so terrible though still very cold, and the summer is too short for much plant growth, the inhabitants are almost as directly dependent on the wild animals. But these are more numerous and there are more opportunities for exchanging furs for other things, and for kinds of food that can be stored for seasons of scarcity.

A great naturalist-traveller, Brehm, has given us many interesting pictures of the peoples in the Far North of Asia. To gain his knowledge of these lands this traveller made two winter journeys through the desolate "Tundras" or "barren grounds" of Asia; over rivers in which the ice was breaking up in great masses; over roads covered three feet deep with rough lumps of hardened snow, and crossed at frequent intervals by the rough, rocky bed of a stream.

Brehm and his followers suffered much from cold, and on one occasion, while crossing a region where disease was raging among the reindeer, they nearly died of hunger. But they survived all these dangers, and Brehm gained what he was working

for,—a knowledge of the life of the peoples of these desolate regions during the coldest months of the year. From what he tells us of some of them, especially of the Ostiaks, we get another good example of the way in which man's life is bound up, even in the smallest details, with the life of animals.

FIG. 4.—Ostiak Hunters with their Reindeer.

Most of the Ostiaks live in a sort of movable hut called a "tschum." It is made of slender tree stems stuck in the ground in a large circle, with their tops brought together and fastened in the centre. This is roofed over with sheets of birch-bark, for the dwarf birch is the only tree which grows at all freely in the more desolate parts of the

tundra. The inside of the tent is lined with skins of beasts, the beds are simply heaps of skins, and the clothing of men, women, and children is made entirely of skins.

The food of the whole family, including even the baby nestling inside its mother's fur hood, consists

Fig. 5.—Huts of Ostiaks of Northern Asia.

of the flesh, raw or boiled, of the beasts killed, along with a few luxuries, such as tea, obtained by exchanging skins on the yearly journey to the nearest market town. So that hunting for the smaller furred animals, and for birds, is naturally the chief business of the men of a tribe.

Winter is the time in which the hunters have most success. They begin in late autumn with the

birds, which are then assembling in immense numbers before flying southwards to more hospitable lands. When they have snared or netted enough of these to keep the women and children in food, the men set out, with sledges and tents, to the edge

FIG. 6.—Interior of an Ostiak Home.

of the forest, on their great winter hunt. Wolves, foxes, sables, martens, squirrels, and many other animals are trapped, mainly for the sake of their fur.

When the snow has fallen, the bear can be tracked to the deep den where he has hidden himself to sleep away the coldest part of the year, and a bear-skin is worth much patient tracking, while bear-hams

make a noble dish. The great elk, so wary and difficult of approach at other times, can be chased on foot through the forest, for the snow will not support its heavy tread. Even the wild reindeer falls a comparatively easy prey at this season.

But when the snow begins to melt, and the ice to break up on the rivers, the hunt becomes less profitable. The elk is sure-footed and swift on dry ground, and the mother bear shakes off her sleepiness, and becomes fierce in defence of the little ones born in the winter retreat. Then the Ostiak begins to move towards the river, and pitches his tent on its banks. The salmon are now ascending in great numbers from the sea to deposit their eggs in fresh water, and for weeks the Ostiak men are busy with boats and drag-nets gathering in as many as possible. Some are used for the immediate needs of the families, but the greater number are scaled, cleaned, split, and dried for future use, or for sale.

The work of preparing the fish for drying falls to the women. They sit on the bank and relieve each boat of its precious load as it arrives, and then prepare the fish with remarkable rapidity. Even the children help in this work, and the very babies crawling about among the workers demand their share of the raw oily livers which all regard as a dainty, while the dogs nuzzle eagerly among the heaps of discarded scales and skins.

In nearly all parts of the world, fish—both of salt- and fresh-water—is an important article of food. But it is in the colder countries, where the land is not very productive, that it reaches its highest value. In Norway, for instance, all through the winter months, when cod, haddock, and other fishes are

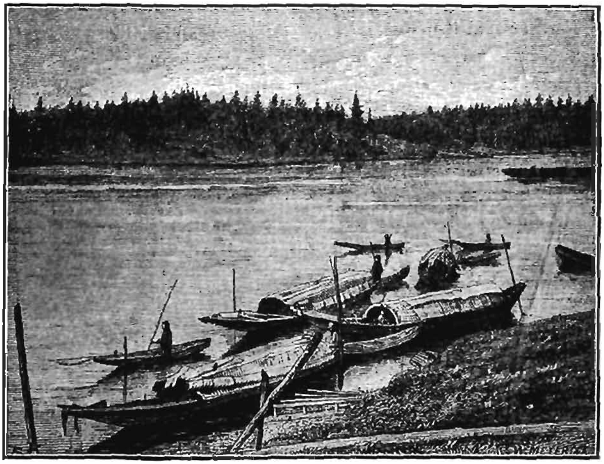


FIG. 7.—Fishing-Boats on the River Ob, Siberia.

swarming in millions up the many inlets round the coast, "so thickly," we are told, "that a boat has literally to force its way among them," many a fjord and bay is a scene of great activity.

Every little village in the country sends out its fishermen, who toil hard all through the winter: some of them putting down and hauling in the heavy nets,

others preparing the fish for drying or salting, that it may be kept for a less abundant season or sold to other countries, which in their turn send to Norway necessaries of which there is not a sufficient supply. It is not for the food-value alone that the fish are so highly prized. The oil extracted from the livers is a most valuable medicine; a fine glue is obtained from the waste parts; and the heads and backbone are dried and ground down into fish-guano, a manure which fetches a high price.

Much the same state of things exists in Newfoundland and Labrador, where practically the whole population depends for a living on the proceeds of the fishing.

In our own country the dependence on fish is less direct and absolute, and therefore perhaps less easy to realise. But let us think of the matter for a little. Let us watch the long line of brown-sailed fishing-boats coming into the harbour of any of our coast villages in the morning after a night of toil at sea; let us watch the mending of the nets, the preparation of the long lines, the gathering of bait, the baiting of the hooks, and the women preparing their creels to carry the fish for sale to the nearest town.

Or let us go to the fish-market in one of our larger coast towns in the early morning, and see the fleet of steam-trawlers and drifters discharging their

loads at the quay; and afterwards see the fish being offered for sale, and carried away in all directions throughout the city, and to the railway station to be sent off to other towns. Let us follow what is sent to the curing yards, and note the numbers of women and girls who have come from all parts of the country for the fishing season; and the men who are busy packing the fish after they are cured, and transporting them to the ships that carry them to many different countries.

If we can see all this, or even if we can make a mind-picture of it all, we shall understand that not only do we owe a great part of our prosperity as a nation to the fishes, but that the lives of thousands and thousands of our people depend directly on "the harvest of the sea."

A great deal has been done, and is still being done, to make sure that this store of national wealth is being drawn upon wisely and carefully, and is not being recklessly exhausted. In the case of a valuable food-fish like the salmon, for instance, a "close-time" is rigidly enforced by law, so that the fish may deposit their eggs in safety, as otherwise they would soon become less numerous.

Experiments are continually being made, too, with the view of increasing the numbers of fish. Countless millions of the eggs which we know on our breakfast-tables as roe, of both salt-water and

freshwater fishes, are hatched out in "Hatcheries," where they are protected from many of the risks they run in their natural surroundings. The young fishes are then transferred to the water in some locality where they are not very abundant. As many as forty million young plaice have been hatched out in a single year in one hatchery on the east coast of Scotland, and taken to the west coast. It is interesting to notice, too, that both the young or fry and the full-grown fishes have been successfully carried to Australia to help to stock its coasts and rivers.

Both in our own country and in other countries on the North Sea, many scientific workers are busy studying the habits of fishes—the food they eat, the changes they go through in the course of their growth, the enemies that prey upon them and their eggs, their spawning-places or nurseries, their migrations, in short, every little detail of their life-histories. Many of these studies have already led to important practical results, and even if some of them may not, at first sight, seem to have any direct connection with the problem of our fish-supply, yet a thorough knowledge is desirable, not only for its own sake, but because, as a great Frenchman once said, "Knowledge is foresight, and foresight is power."

CHAPTER II

DOMESTICATED ANIMALS

In the cases we have been considering, the relations between man and animals have been hostile ones — man has been the hunter and the animals his victims. This, as we said before, is the simplest and most direct relation between them, and therefore was certainly the earliest. But very early in the history of mankind, so far back that in most cases we cannot find out exactly when or how it began, man took certain animals into a sort of partnership with himself. It is likely that he did this in the first place simply from a desire for their companionship, and without any intention of profiting by them.

Many savage tribes at the present day have all sorts of pets, especially great handsome birds like the crane and the flamingo, which are of no sort of use to them, but which live among them quite fearless, because they are never unkindly treated. It is probable that these tribes have a certain feeling for the beauty of these birds, and a certain pleasure in their companionship; but it is also certain that man often tames and teaches young animals simply because he likes doing it.

We know that all boys, if they live near enough to the country, are fond of catching and rearing all sorts of beasts and birds — squirrels, rabbits, field-mice, owls, crows, and even frogs or toads. Every child lives through in its own life some of the stages along which the race has passed, and in the early days of which we are speaking, mankind was still young, and men may well have had some of the instincts and desires that are strong in boys to this day.

The animals themselves may have had something to do with the beginnings of this partnership with man. Huntsmen have told us that, when they are hunting in districts where wolves and jackals—the wild relatives of the dog—are common, these animals become bolder and bolder as time goes on, at first following at a long distance to pick up what may be left of the kill, but gradually coming closer until they are practically camp-followers of the hunting party.

Some animals showed themselves much better suited than others for association with man. Some of them remained wild and shy, never lost their suspicion of man, never became friendly, or even indifferent to his presence, and would not bring forth their young unless they were in full freedom. It is interesting that particularly those animals which *play* when they are young, such as puppies,

kittens, lambs, and kids took most kindly to living with man. Man may have been attracted to them in the first instance by their playfulness, but there is no doubt that the playful animals are the ones that most readily adjust themselves to changed surroundings. Those, too, whose natural instinct is to live in flocks or herds led by the strongest among them, adapted themselves easily to the new life, and apparently accepted man as their leader.

Man soon began to see the advantages that could be gained from this partnership, and to choose for his companions the animals that could be of most use to him. For instance, the dog very early became accustomed to associate with man, and showed a great power of attaching himself to a particular master. As the master at that stage depended for food mainly on what he could kill, he soon discovered that the dog could help him to find and secure his prey. So he trained the young dogs from the first, having them with him continually, and while they helped him to find food, he gave them an abundant share, and also gave them shelter, and protection from their enemies. So the threads of their lives and of his became more and more closely interwoven.

There were even more direct advantages to be gained from other animals, and when the dog's help

had been secured, it was easier to bring others into subjection. It was much easier to take a sheep, or a bullock from the flocks and herds growing up about the village, than to go out to hunt for wild animals, which had often to be tracked for days, and even then were not always to be had in sufficient numbers to feed the whole tribe. So, as

FIG. 8.—Dogs towing a Boat on the Yeniseï River.

the herds grew in importance, as their milk came to be valued as food, and their wool and hair to be used for the necessary clothing, more and more time was devoted to the care of the domestic animals, and hunting came to be regarded rather as a manly sport than as a necessity.

This brought about changes, both in the animals and in their owners. The animals, as they learnt to depend more and more upon man to supply their

needs, became, not *better*, but more suited for man's purpose, so that now many "domestic" animals look quite different, and have many habits different from those of their relatives which have always lived a wild life.

Man himself had also to change; for the courage and quickness which were enough for him as a hunter were not now so much needed as forethought, and patience, and regular industry. His whole way of life, too, had to be altered gradually to suit the new conditions.

We must, of course, understand that the keeping of flocks and herds became the chief, though not necessarily the only occupation, not of all peoples, but only of those who lived in regions specially suited to it. The dwellers in the mountains and on the outskirts of the great forests remained mainly hunters, though they also learned to keep animals and to cultivate the ground. Those in low-lying, well-watered districts, and in fertile valleys devoted themselves more and more to cultivating the soil, and in course of time learnt to employ animals to help in this just as we do now.

Men in countries with wide, grassy plains and low hills gave themselves up more and more to the keeping of herds and flocks, hunting only for sport or when special opportunity offered, and in most cases cultivating only small patches round about

their homes. Among those "pastoral" peoples, as they are called, a man's wealth was estimated by the numbers of his herds of cattle, and flocks of sheep and goats, as it was, for instance, among the children of Israel.

As the flocks and herds increased in number they required more and more food, and very soon exhausted the grass and plants in the immediate neighbourhood of the villages. The inhabitants were therefore obliged to make their houses movable so that, as soon as the grass was eaten up in one place, they might easily move on to another. Instead of living in huts, they took to tents of different kinds, and led a wandering life.

On the wide grassy plains or "steppes" of Central Asia there are many tribes of these wandering or nomad herdsmen. Brehm, the naturalist-traveller of whom we have already spoken, has given us an interesting picture of the life of one of these tribes, the Kirghiz, among whom he spent some time.

During winter each band or "horde" of Kirghiz settles down in some hollow where the low hills keep off the biting winds. Here the people build roughly thatched shelters for their flocks and herds, and here, too, they store the hay that they have cut down throughout the summer, for on it the lives of their beasts, and therefore their own lives largely

depend. When the winter is not very severe they live quite comfortably, killing one of their animals for food as they require it. But if the snow lies long on the ground, and especially if it freezes hard, so that it cannot be scraped away, the

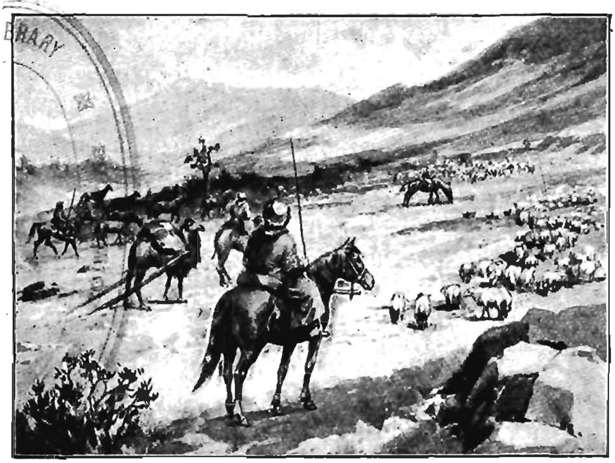


FIG. 9.—Kirghiz Shepherds with their Herds.

animals may suffer from scarcity, and many of them may perish.

In the end of April or the beginning of May all is bustle and excitement, for the pleasant, wandering, summer life is about to begin. Thousands of years of experience have taught the Kirghiz to make a movable dwelling which is easily set up and taken down, which can readily be carried from

place to place, and yet is warm and comfortable, and steady enough to resist a violent storm. The Kirghiz "Jurt," as it is called, is said to be "the most perfect of all tents." The low walls are made of a light wooden lattice-work which can be con-

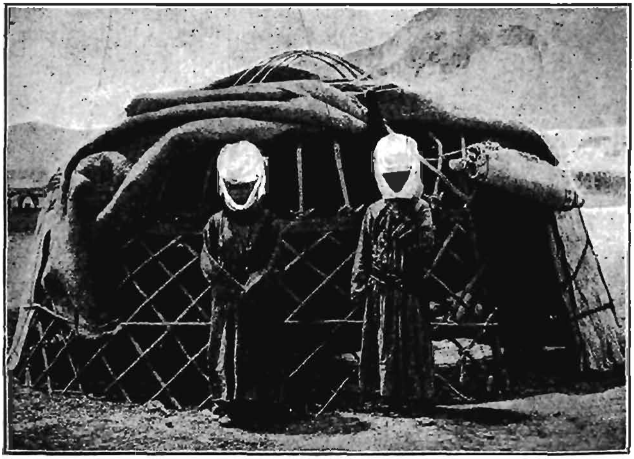


FIG. 10.—Kirghiz "Jurt" or Tent.

tracted or expanded, and fits into a ring at the top. Arched spars jointed into the ring form the roof, and the outside is covered with ingeniously fitted mats of felt and woven grass, the whole being bound together with strong cords. The inside is lined with brightly coloured rugs, often beautiful and valuable, which the Kirghiz loves to collect.

Early in the morning the flocks and herds set

off under the charge of boys mounted on oxen. They travel very slowly, nibbling as they go, for the lambs and kids, which are driven in separate flocks in front of them, are only a few weeks old. The men drive the horses, riding themselves, and the women remain behind to take down the jurt and pack it and all their household belongings on the backs of oxen, or, when the tribe is a wealthy one, of camels. This done, they mount their own horses with their little children and ride after the rest, whom they soon overtake. At mid-day a halt is called, and all the milk-giving animals are milked. Throughout the summer, milk is the chief food of the Kirghiz, varied only by rough lumps of dough sodden in fat, and very occasionally by rice. Meat is only eaten on high festival days, except in winter when there is no milk.

When the flocks have rested and grazed sufficiently, the whole assembly moves slowly on again till the camping-ground is reached. Then comes a busy time. The tents of the different families are set up again by the women who have hurried on ahead. By the time that is done they are ready to receive the flocks of goats and ewes which the men, with a little help from the dogs, have gathered in. All the mother animals are attached by a noose to a long rope stretched between two poles, and are thus kept still during the process of milking.

The milking over, the animals are released and immediately rush off, bleating eagerly, in the direction in which they know their lambs and kids must soon appear. The flocks of little ones hear their mothers' voices, there is an excited rush pell-mell down the hillside, and the two flocks soon

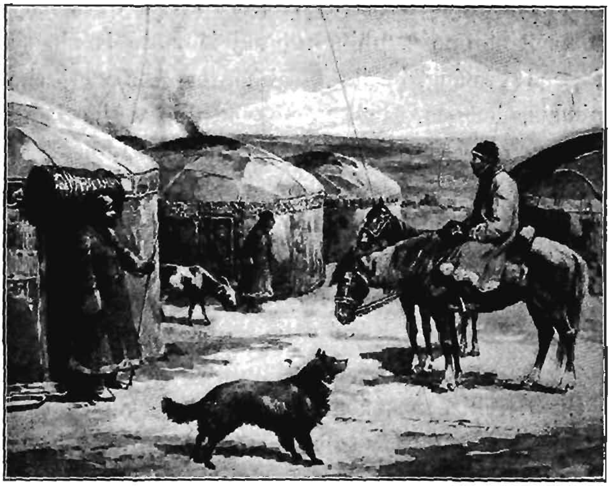


FIG. 11.—Kirghiz Camp.

come together in what at first sight appears hopeless confusion. But after a few minutes of sniffing, pushing, and bleating, each mother has found her own young one, which is soon eagerly sucking the milk that still remains for it. After mothers and young have enjoyed each other's company for a time, the women, who had meantime been attending

to the wants of their own little ones, catch all the lambs and kids and fasten them side by side to a long rope, so close to one another that the mothers cannot get in between them to lie down beside their own young.

The evening meal is now prepared, and soon the whole encampment is at rest. Several days may be spent at one camping-ground if there is plenty of good grazing in its neighbourhood for all the animals, but as the summer advances the band hastens onwards to reach the cool freshness of the grassy hillsides. Each "horde" has its own particular route which is followed every year, so that none ever encroaches on another's territory.

"It is not their own humour," says Brehm, "but the necessity of satisfying the requirements of their stock that regulates the roamings and sojournings of the Kirghiz, that compels them to wander this way to-day and that to-morrow, to rest for a little in one place, and shortly afterwards to leave it for another. The journeyings of these people are by no means aimless wanderings about the steppe, but carefully considered changes of residence, determined by the season, and by the species of animal requiring fresh pasture.

"The various herds have different needs: sheep and goats like hard, fragrant plants, such as are to be found on the salt steppe; horses prefer the

mountain plants, especially those growing among masses of rock; while the favourite grazing ground of cattle is soft meadow-land; and camels, besides eating the hard steppe plants, appear to look upon thorns and thistles as an indispensable part of their food."

So the herdsman must arrange his whole way of living according to the needs of his flocks, if he is to live at all. Not only is their milk and their flesh almost his sole food, but their skins, wool, and hair supply the whole of his clothing, the bedding, the mats for his tent, and the cords which bind it together. Some of the animals must be sold every year to pay his taxes to the Government, and be bartered for other comforts which they cannot themselves supply.

CHAPTER III

DOMESTICATED ANIMALS (*continued*)

THE animals kept by different peoples must, of course, vary according to the climate and the character of the country. So, just as we saw that some races depended on one or two kinds of animals which they could kill, we find that the life of other races is intimately bound up with one or two particular

domestic animals. One of the best instances of this is to be found in northern regions, not quite so far north as those inhabited by the Eskimos of whom we have spoken already.

In Lapland, Finland, and the northern parts of Siberia the cold is too severe for horses, cattle,

FIG. 12.—Ostiak Hunter with Reindeer and Sledge.

sheep, or any of our ordinary domestic animals, but their place is filled, and well filled, by the reindeer. The dog is the only other of the larger land-mammals which now thrives in those countries, but though it is valued as a companion, and used for drawing sledges, it is not of the same importance as the reindeer. The flesh of the reindeer is the people's chief food; its milk is highly valued by

most races; its skin furnishes them with bedding, clothing, and boots. Many drinking vessels and other utensils are made from its horns and bones; its sinews supply strong thongs; and the needles through which these are threaded are made from splinters of bone.

The Laplander rides on his reindeer, the Ostiak makes it draw the sledge on which he has packed his birch-bark tent, and his wanderings are regulated by the needs of the reindeer, just as are those of the Kirghiz farther south by those of his flocks and herds. Not quite in the same way, however, for the reindeer is not nearly so tame as the flocks and herds. It is a much shorter time since it was pressed into the service of man, only about a thousand years or so, naturalists tell us, and that is quite a short period in the history of a race.

So the reindeer has not yet adapted itself fully to domestic life, but remains quite like his wild relative, with many of the same habits. His master, therefore, has to follow where he leads, instead of driving the deer where he himself wishes to go. Fortunately the deer have a regular beat of their own, and rarely wander from the tracks their forefathers have been stamping down for generations. Early in summer they make their way slowly up to the mountain heights, partly for the fresher grass and cooler air, but partly also to escape from the

innumerable hosts of flies and mosquitoes which make life a continual torment on the plains during the hotter months.

In autumn, if the reindeer are within reach of the sea, they make a rapid eager rush towards the shore, where they browse for a time on the salt sea-

FIG. 13.—Lapp Sledge.

weed thrown up by the waves. One writer gives us a beautiful picture of this rush for the sea. "They grow unruly, and it is hard to harness them in the light sledge. As the days pass the Lapps watch them more and more closely, well knowing what will happen sooner or later; and then, at last, in the northern twilight, the great herd begins to move. The impulse is simultaneous, irresistible,

their heads are all turned in one direction. They move slowly at first, biting still here and there at the rich moss. Presently the slow step becomes a trot, they crowd closely together, while the Lapps hasten to gather up their last unpacked possessions—their cooking utensils and their wooden gods.

FIG. 14.—Sledge used by Samoyed People of Northern Asia.

"The great herd break together from a trot to a gallop, from a gallop to a breakneck race, the distant thunder of their united tread reaches the camp during a few minutes, and they are gone to drink of the Polar Sea. The Lapps follow after them, dragging painfully their laden sledges in the broad track left by thousands of galloping beasts, a day's journey, and they are yet far from the sea.

The trail is yet broad, and on the second day it grows narrower, and there are stains of blood to be seen; far in the distant plain before them their sharp eyes distinguish, in the direct line, a dark motionless object, another, and another.

"The race has grown more desperate and more wild as the stampede neared the sea. The weaker reindeer have been thrown down and trampled to death by their fellows. A thousand sharp hoofs have crushed and cut through hide and flesh and bone. Ever swifter and more terrible in their motion, the ruthless herd has raced onward, careless of the slain, careless of food, careless of any drink but the sharp salt water ahead of them. And when at last the Laplanders reach the shore their deer are once more quietly grazing, once more tame and docile, once more ready to drag the sledge whithersoever they are guided."

Much farther south, in the hot sandy deserts of Arabia, we find a very different animal in close partnership with the inhabitants. The one-humped Arabian camel has been associated with man so long that no wild variety of it can now be discovered. It is true that immense herds of the two-humped Bactrian camel live wild on the great plains of Central Asia, but many of these are thought to be the descendants of individuals which have escaped from domestication

Of the one-humped species no wild form is known, and it has been in the service of man so long that it is quite impossible to tell what it was like in its days of freedom. In the

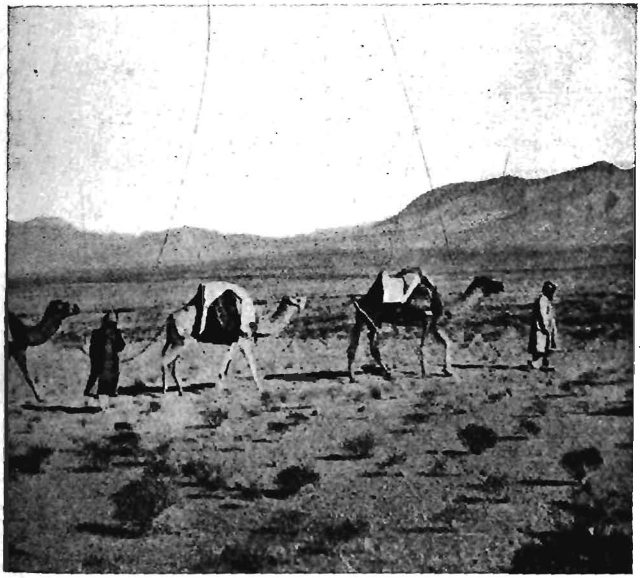


FIG. 15.—Camel Caravan.

course of long ages it has become more and more suited to the country in which it lives, and to the work it has to do, so that it is quite indispensable in the deserts.

The feet of the camel are broad and flat, and instead of being protected by hoofs, they have

expanded cushion-like soles enclosed in a hardened skin, which is not sensitive to the burning heat of the sand.

This kind of foot makes it possible for a camel to walk over sand bearing a heavy load or a rider,

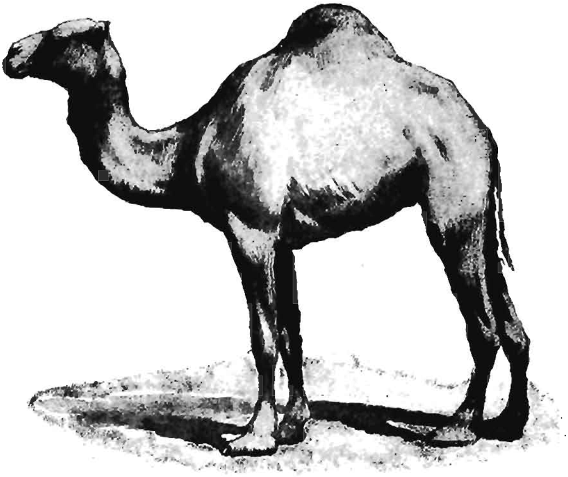


FIG. 16.—*One-Humped Arabian Camel.* About 8 feet in height.

where a horse or other hoofed animal would sink and flounder at every step. The nostrils of the camel are slits which it can close at will to prevent the sand being blown into its breathing passages. Its hump is a storehouse of fat, and when, as often happens, it has to go for a time with very scanty food, the fat is gradually absorbed to nourish the

body, and so the camel is able to hold out until better times come. When the camel reaches good fresh grass, or any kind of green plant, the hump very quickly swells up again.

But, long as the camel has been in the service of

FIG. 17.—Two-Humped or Bactrian Camel. About 8 feet in height.

man, he cannot be called a willing servant like the horse or the dog. He shows no affection for his master, and his master shows very little for him. As one writer remarks, "it is hard to be civil to a beast whose face is a sculptured sneer." But he is said sometimes to revenge himself on a master who has treated him badly. He is not intelligent

enough to *try* to help, as a horse or an elephant does; he carries whatever is put on his back, and goes where he is driven, but he grumbles all the time, and if, on a journey, he turns aside to eat, it is said that he has not wit enough to turn back, but will wander stupidly on in the new direction.

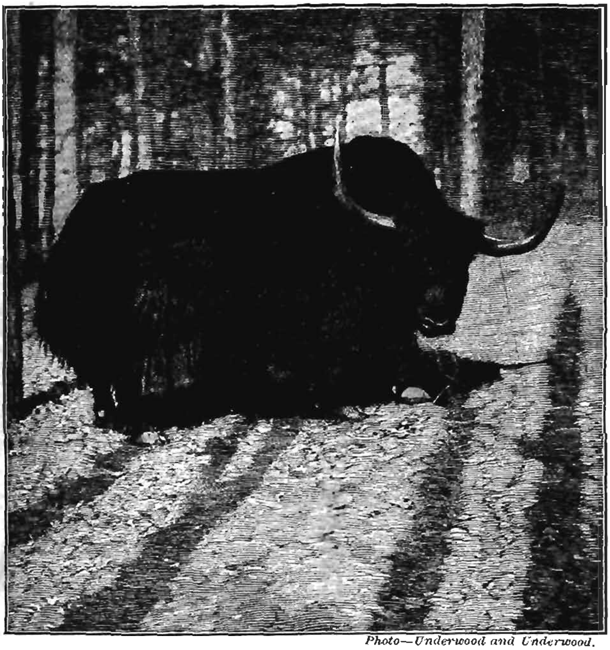
The two-humped camel is better suited for a colder climate and for harder country, and is safe on hilly ground where his one-humped cousin would be useless.

There are two interesting relatives of the camel—the Alpaca and the Llama—in use in the mountainous parts of South America. They are both supposed to be descendants of wild camel-like animals, the Guanacos, which have become what they are now in the course of long association with man. The milk and flesh of both is used, but the Alpaca is kept chiefly for the sake of its long fine hair, the Llama as a pack-carrying animal. Its pace is slow, but it requires little attention; it feeds as it goes, and one man can guide a long train of laden animals, so that it is very valuable in hilly districts.

In the very mountainous parts of Asia, like Tibet, the people depend entirely upon another very interesting animal, the Yak. This is a very strong and shaggy member of the cattle-tribe, whose real home is among the mountains at the height of more than 6000 feet. It will cheerfully push its way

up a rough rocky hillside, or through deep snow, carrying a heavy load on its back.

The yak does not need any special care; it finds



Photo—Underwood and Underwood.

FIG. 18.—A Yak, or species of Ox which lives in the mountainous regions of Tibet.

most of its own food, so that it can be kept by the poorest; its milk is rich; its flesh is tender and savoury; its long hair is valuable for weaving into coarse cloth; and, although inclined to be unfriendly to strangers, it is gentle and docile towards its

masters, so that it is a very valuable partner to the mountain peoples. The whole of the carrying of merchandise between Northern China and Tibet is done by yaks.

As to the number of domesticated animals that play a part in our own life, we can each make for ourselves a long list, which must include all our ordinary farm animals, whether they supply us directly with food or help us to get it by their work in cultivating the soil, our four-footed household pets, and all our feathered partners, from the useful hen to the decorative and cheerful canary.

There are two "domesticated animals," however, which should be specially mentioned, because they are the only ones taken from among the backboneless animals. The first of these, the hive-bee, is familiar to us all, and we shall have more to say about it when we come to deal with animal societies. The other is the "silk-worm," and it is much less well-known in this country, as it is not reared except occasionally as a "pet."

The reason for this is that the particular food-plant—the mulberry tree—with which the life of the "silk-worm," as the caterpillar is called, is bound up, does not thrive well in this country. So we have to get what silk we want from warmer countries, for all the silk used in the world is produced by these little creatures.

The partnership with man has not been altogether an advantage to the silk-worms. They have come to depend so much on their owners for care that they no longer know how to take care of themselves. We are told, for instance, that when they are kept on trees in the open air, instead of inside a room as is usual, if a caterpillar falls off the leaf on which it is feeding, it does not make for the trunk of the tree and climb up again as any other kind of caterpillar would do, but simply lies where it falls until it is picked up, or dies. On the other hand, man protects them from the birds and insects that would eat many of them if they were living in a natural state, and thus so many more are hatched from the same number of eggs, that we can use a great many of the cocoons without fear of killing off the silk moths, or even of reducing their numbers to any great extent.

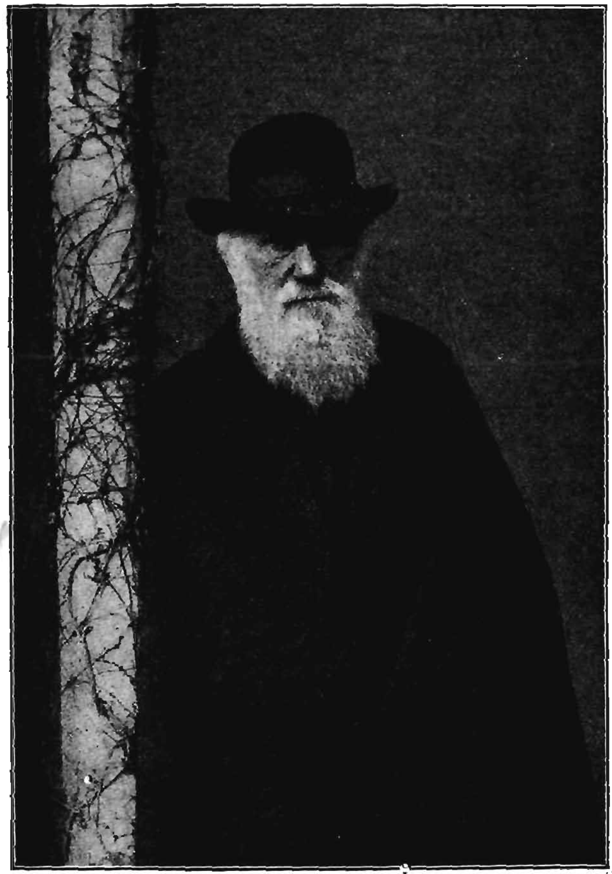
A more serious disadvantage from man's point of view is, that the silk-worms which yield the best silk have become delicate and liable to a disease which kills off thousands of them and causes great loss. But attempts are continually being made to cure this delicacy by introducing other "wild" silk-moths of nearly related kinds among them, so that the caterpillars may have some of the vigour of the free-living kind combined with the fineness of silk of the domesticated form.

All the animals which we have been describing have been in a state of domestication from very early times. We seem to have lost the art now, for, with the single exception of the ostrich, no large animal has been added to the list for many centuries. We have, however, succeeded in introducing into other countries animals which were early domesticated in a different part of the world. For instance, the Angora goat, the long, white silky hair of which has been an article of commerce in Asia for centuries, has been introduced into Cape Colony; and its hair is said to be even better in quality there than in its original home.

But it is in the direction of improving the animals we have already that the greatest progress has been made in recent years. For, though it had long been known that races could be improved by carefully choosing out the best among them, it is only since the time of Darwin that the improving of the different animals has become a careful scientific study.

For Charles Darwin, the great English naturalist, not only saw the intricacy of the web of life more clearly than any one had done before him, he saw also that the web is still a-weaving, and that the pattern of it is continually changing. That is to say, he understood and made plain to us that animals and plants are not what they have always

been, but that they have *become* what they are



Photo—Elliott and Fry.

FIG. 19.—Charles Darwin.

because they are continually changing from genera-

tion to generation, and because those that are least suited to the particular conditions of their life are always being sifted out, while those that are fittest to the conditions survive and multiply. By his careful study of the changes that have occurred and are still occurring in man's captives, Darwin laid the scientific foundation on which the sure improvement of our domestic animals must rest.

Now we must turn to quite a different kind of partnership between men and animals. In domesticating animals, man has acted more or less deliberately from the first; he has intentionally brought their lives into closer and more intimate connection with his own. But there are a great many cases in which animal life affects human life, often to a very great extent, without any intention on man's part, and indeed often without his knowledge. One of the animals which is thus useful to man is so important, and the story of its life is so interesting, that we must give it a chapter to itself.

CHAPTER IV

EARTHWORMS AND THEIR WORK

In 1777 a great naturalist, Gilbert White of Selborne, wrote to a friend: "The most insignificant

insects and reptiles are of much more consequence, and have more influence in the economy of nature than the incurious are aware of; and are mighty in their effect, from their minuteness, which renders them less an object of attention, and from their numbers and fecundity. Earthworms, though in appearance a small and despicable link in the chain of nature, yet if lost would make a lamentable chasm. . . . Worms seem to be the great promoters of vegetation, which would proceed but lamely without them, by boring, perforating, and loosening the soil, and rendering it pervious to the rains and the fibres of plants; by drawing straws and stalks of leaves into it; and, most of all, by throwing up such infinite numbers of lumps of earth called worm-casts, which, being their excrement, is a fine manure for grain and grass." Gilbert White concludes by hoping that the "inquisitive and discerning" will set to work, because a complete study of earthworms would "afford much entertainment and information at the same time, and would open up a large and new field of natural history."

But it was not until Darwin, more than a century later, published a book on earthworms, for which he had been carefully and patiently making observations, experiments, and calculations throughout many years, that it was generally realised how great is the part played by earthworms in making the earth fertile.

Darwin's labour has given us one of the most wonderful examples of the great results that may be accomplished by the adding up of many apparently trifling pieces of work, of "summing up the effects to a continually recurrent cause," as he himself said in answer to another naturalist, who objected that such a weak creature as the earthworm could not possibly have accomplished such "stupendous labour."

In order to understand something of Darwin's calculations, we must make sure that we know something about the earthworm and how it lives.

The body of the earthworm is made up of a great number of rings, sometimes as many as two hundred, and each ring bears two pairs of bristles on each side. The head end is slightly pointed, and a very sensitive hood, which helps in taking hold of leaves and the like, projects beyond the mouth. There are no eyes, but the front part of the body is sensitive to light; no ears, but the animal, though it cannot hear sounds, is very quick to feel the slightest vibration of the soil.

The earthworm makes for itself a burrow, which runs down two or three feet, and often to a much greater depth, below the surface. The burrow usually ends in a slight enlargement. In very loose soil, such as ploughed land or garden ground, the earthworm makes this burrow by simply boring

its way down, head first, and displacing the particles of earth. As it bores, the working of its body rubs the walls of the tunnel smooth, and a sticky secretion from the skin coats them over and hardens them, so that they do not fall together again when the worm has passed.

When the soil is at all hard, or when it is

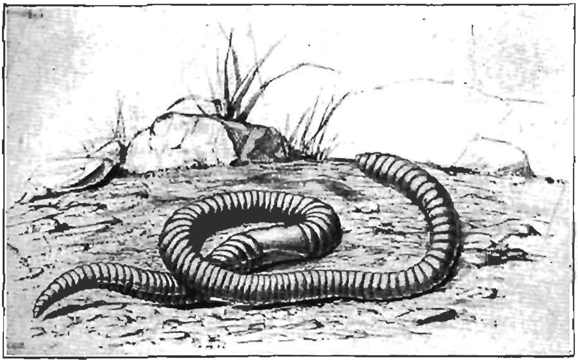


FIG. 20.—An Earthworm. Natural size.

bound together with grass-roots, it is impossible for the earthworm to bore in this way, and in that case it *eats* its way down. The soil taken into the mouth passes down the gullet into the crop, and then into the gizzard, a sort of muscular mill in which it is rubbed and ground into a very fine powder. Little stones are often found inside the gizzard, and are supposed to aid in the grinding process. The finely powdered soil passes through

the digestive tube, and on the way the minute organic particles, bits of leaf or of animal remains, that it contains are digested for food. The earth itself, mixed with digestive juices, is thrown out of the body, either at the mouth of the burrow or within it, in the form of the " worm-castings " so familiar to us all.

Within the burrow the earthworm passes the day; and even at night, when it comes out to feed, it sometimes keeps the posterior end of the body within the opening, so that the rest can be drawn in quickly if danger threatens. The soil eaten by the earthworm supplies only a small part of its food; the greater part consists of decayed leaves and other vegetable matter. To get this food, it lengthens out its body so far as possible, slowly sweeps the ground in a circle round its burrow, dragging all it can seize to the mouth of the tunnel, and taking some of the leaves down to its underground chamber.

The little heaps of leaves are covered over with a digestive juice, which has the effect of softening them so that they can be easily nibbled by the earthworm's toothless but very muscular mouth. Leaves are used also to cover up the mouth of the burrow through the day, perhaps partly to conceal it and partly to keep it from getting too dry, for the earthworm cannot live without a good deal of moisture.

Here we have already the three ways pointed

out by Gilbert White in which worms are "promoters of vegetation." The burrows tunnelling for several inches, and often for several feet, everywhere under the surface, allow the air and rain-drops to penetrate throughout the soil, and they also make it possible for the delicate rootlets of plants to pierce their way down to a sufficient depth to find abundant food and moisture. The deserted burrows gradually crumble and collapse, and thus the whole soil is kept in very slow but continual movement, and all in turn exposed to the action of the air and rain.

The numerous decaying leaves carried down into the burrows, or buried under heaps of castings on the surface, enrich the soil and make it more suitable for plant growth. The digestive fluid, with which the worms cover the leaves, hastens their conversion into rich vegetable mould.

Finally, castings of finely powdered soil are continually being brought up from some depth and thrown out at the surface; for it is not alone to make its burrow that the earthworm eats the soil; it does so at all times for the sake of the food-particles contained in it, though it eats smaller quantities of earth where leaves and other vegetable matter are abundant. The whole surface is thus in the course of time covered over with a layer of fine, rich soil brought up from beneath.

Now as to the summing up, and Darwin's manner of setting about it. He began his observations by keeping earthworms in large flower-pots beside him in his study, watching all their ways, and making experiments to find out which kind of food they liked best; how they knew one kind from another; how they dealt with the different shapes of leaves so as to drag them underground; what effect the digestive fluid they pour out had on the different kinds of leaves; at what time the earthworms are most active; how much soil they pass through their bodies in a given time, and a great many other interesting points. Lest there should be a difference in the habits of worms kept in a comparatively small space, Darwin checked his observations continually by others made out of doors by the light of a lantern.

To get at some idea of the effect produced by earthworms on the earth, another set of experiments was necessary. Stones were carefully watched, and the rate at which they sank into the ground was noted for many years. Part of a field was covered over with broken pieces of chalk and left undisturbed for thirty years. At the end of that time a layer of lumps of chalk was found 7 in. below the surface. Another field, which was so covered with hard flint stones that it was known as "the stony field," was also left untouched for the same

length of time, and at the end of it, we are told, a horse could gallop from one end of the field to the other without ever striking his hoof against a stone.

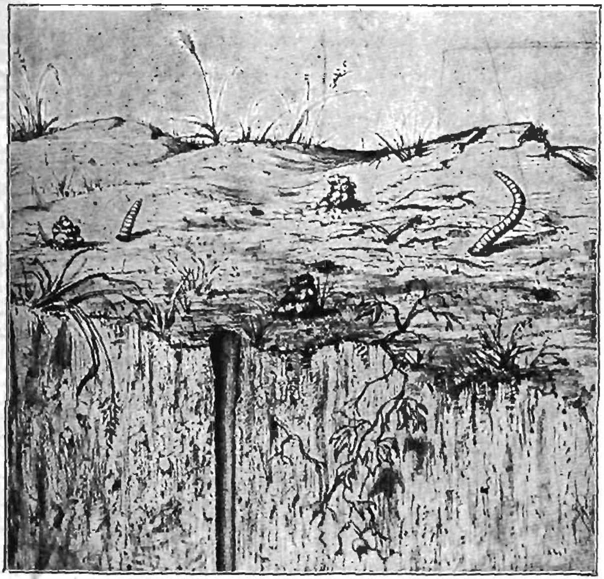


FIG. 21.—Earthworm Burrow and Castings.

More accurate figures were obtained in another way, which entailed constant labour. Squares of land were marked out on different kinds of country, and every day for a year these squares were visited, all the worm-castings on them were collected, dried, and weighed. On one such square yard the castings'

for the year weighed exactly three and a half pounds. This means that on an acre of similar ground more than seven tons of dry earth are being brought up to the surface every year by the earthworms.

The figures for some of the other measured areas are even larger than this. But it is not very easy to realise them, and we shall do better to read Darwin's own summary.

"When we behold a wide turf-covered expanse, we should remember that its smoothness on which so much of its beauty depends, is mainly due to all the inequalities having been slowly levelled by worms. It is a marvellous reflection that the whole of the superficial mould over any such area has passed and will again pass every few years through the bodies of worms. The plough is one of the most ancient and valuable of man's inventions; but long before he existed the land was in fact regularly ploughed, and still continues to be thus ploughed by earthworms. *It may be doubted whether there are many other animals which have played such an important part in the history of the world as these lowly organised creatures.*"

Let us not forget, however, that the earthworms are not *trying* to be useful to mankind. Far from that, they have no scruples whatever about nibbling our young corn and our tender cabbages, and they

have a particular fondness for our celery and carrot tops, though the damage they do in this respect is trifling. Moreover, they are quite as "useful" to the voracious little centipedes who follow them into their burrows, to the blackbirds that pick them cleverly out of the mouths of the burrows where they love to lie in the early morning, or to the moles who break into their underground chambers and devour them when they are lying coiled up together during the cold days of winter. The earthworms are simply living their lives, and that the threads of their lives are interwoven with so many other threads does not concern them in the least.

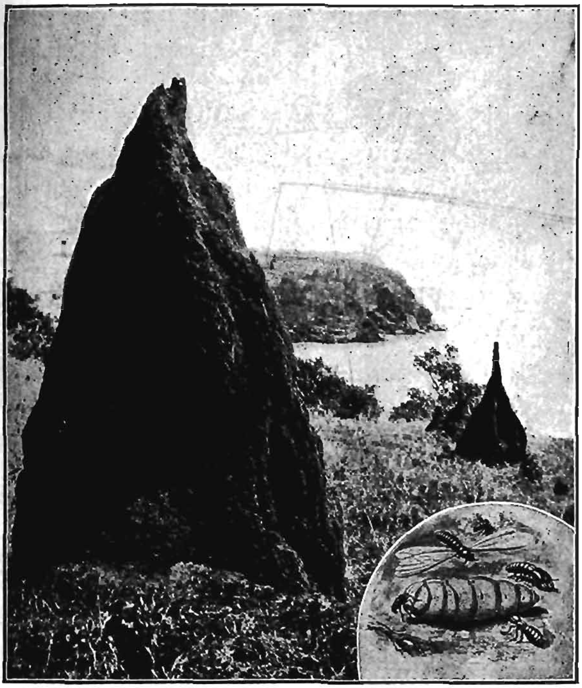
Earthworms are found in nearly all parts of the world, up to a height of about 10,000 feet. As we have seen, however, they require a certain amount of moisture, so that in extremely dry regions they cannot thrive. But though the earthworm is the most important of "Nature's ploughmen," it is not the only one. In the hot regions of tropical Africa, where earthworms cannot work at all, or only for the few weeks of the rainy season, we find another animal at work in the soil in a somewhat different way. This is the "white ant" or termite, and we owe our knowledge of the usefulness of one part of its work to a well-known naturalist, Professor Henry Drummond, who studied its ways during a visit he paid to the interior of Africa.

The white ant, which is not strictly an ant at all, though it goes by that name, is a soft-bodied insect which feeds chiefly on dead or decaying wood. The most remarkable point about its way of living is that it never comes above ground. Yet to get at the crumbling wood on which it feeds, it must often crawl up to the very tops of high trees. How, then, does it get over its dislike to exposing its soft and juicy body to the view of its many hungry enemies? It takes the ground along with it.

"I have seen," writes Professor Drummond, "white ants working on the top of a high tree, and yet they were underground. They took up some of the ground with them to the tree-top; just as the Esquimaux heap up snow, building it into the little tunnel huts in which they live, so the white ants collect earth, only in this case not from the surface but from some distance underneath the ground, and plaster it into tunnelled ways. . . . Millions of trees in some districts are thus fantastically plastered over with tubes, galleries, and chambers of earth, and many pounds weight of earth must be brought up for the mining of a single tree. The earth is brought up grain by grain in the jaws of the insects, and each grain is covered over with a moist slimy fluid to keep it in its proper position. These tunnels, which are about the thickness of a small-sized gas-pipe, often run up to the very tops of high trees and

out to the end of every branch, and all the trees of a forest may thus be covered with them."

In addition to all this, the termites make a "much



1 2
FIG. 22.—1. Termite Hill. 2. Termites—Queen and Workers.

more elaborate system" of tunnels underground, sometimes running down below the surface for several feet. All the soil brought up from below is used in making the above-ground tunnels and in

the construction of elaborate edifices, with nurseries and granaries—huge ant-hills which may be seen for miles. "Thus there is, so to speak, a constant circulation of earth in the tropics, a ploughing and harrowing, not furrow by furrow, and clod by clod, but pellet by pellet, and grain by grain."

But the termites, like the earthworms, are simply living their own life. They have no idea of doing all this work to benefit man; they cause him a great deal of annoyance in other ways. The same writer who gives us such an enthusiastic account of their usefulness, tells us that they do not confine their attention to clearing up dead branches of trees, but will eat through the very logs of which a house is built, till it suddenly crumbles into dust. Tables, chairs, trunks are attacked and reduced to matchwood; and "in many parts of Africa, if a man lay down to sleep with a wooden leg, it would be a heap of sawdust in the morning!" Here again a knowledge of the natural history of the creatures has led to useful protective devices on man's part. He puts thin sheets of corrugated iron in the foundations of his houses, he uses iron telegraph posts, he "smokes" the underground system of burrows, and he—or, in this case, she—seeks for the big queen termite, the destruction of which always means less trouble in the house the next year.

CHAPTER V

MAN'S STRUGGLE WITH ANIMALS—THE FLESH-EATING ANIMALS

So far we have seen man hunting and fishing, training animals to work for him, and profiting, sometimes without knowing it, by the labours of the earthworm and other lowly creatures.

But there is another side to the picture. The rest of living nature does not exist for man's benefit; he has to work hard to maintain his own footing, and the animals are often his rivals in the struggle for existence. Among ourselves this struggle is no longer so obvious and direct as it was in earlier times, when the larger animals were much more numerous than they are now. But, as we shall see later, it is as real as ever.

In many parts of the world there is still a keen and direct, almost hand-to-hand struggle with the larger carnivores or flesh-eating animals, which are dangerous to the life of man himself, and to his flocks and herds. First among these rivals of man we must place the animals of the Cat family. The lion is now found only in a small part of Asia, and throughout the wilder parts of Central and East Africa, and its range is becoming rapidly narrower.

For though the lion has enormous strength, it is not so cunning as some of the other great cat-like animals, and against the weapons of civilised man cunning is a more effective protection than mere strength.

The lion has few tricks except concealment. It rarely leaves its lair during the day, or even in

FIG. 23.—Lion prowling round a camping-place.

bright moonlight, unless driven to do so by extreme hunger. In daylight it is stupid, and easily becomes bewildered when it is hunted. But under cover of darkness the King of Beasts deserves its name. Then the lion is bold and fearless, giving full play to its glorious strength, and letting its roar thunder through the forest, so that every animal that hears it shudders with fear.

Where the larger wild game which is the

Most of the tiger stories come from India. But the animal is really found throughout a great part of Asia, as far north as Siberia. The tigers that live in the more northern regions are covered with very thick long hair, which enables them to endure the cold.

In the more thickly peopled parts of India tigers are no longer abundant, but wherever the jungle is extensive enough to afford them shelter and sufficient food there are still a great many. They abound especially in dense thickets of reeds along the banks of rivers, and in the wooded islands at the mouth of the Ganges. The natural food of the tiger is the wild pig, and the deer, and other grass-eating animals which swarm in the jungle; and we must bear in mind that, even looked at from man's point of view, the tiger has its uses. For the wild pig and the deer do terrible havoc among the crops, and if it were not that their numbers are kept in bounds by their natural enemies, they would increase to such an extent that agricultural work in the clearings, or in the fields near the jungle, would be quite impossible.

Unfortunately for man, however, the tigers do not confine themselves to their natural prey. Some of them acquire a taste for the more easily obtained cattle and other domesticated animals that are sent out to graze in the neighbourhood of the villages

by day, and a bullock may be taken from the herd two or three times every week. Sometimes, too, a tiger becomes a confirmed "man-eater," not always because it is growing too feeble to bring down stronger game, but apparently because it has come to prefer human flesh to any other. It is told of

FIG. 24.—Tiger pulling down a Bullock.

one tigress that she killed one hundred and eight persons in three years, and of another that her depredations drove the inhabitants of thirteen villages away from their homes, and caused a large tract of cultivated country to be abandoned. The natives, if unarmed, rarely attempt themselves to kill a man-eating tiger, but apply for help to Europeans, who are usually very ready to seize

the opportunity for so exciting a hunt. Nowadays, therefore, a tiger that takes to man-eating is quickly cut short in his evil career.

The leopard has been called "a beast of prey brought to the highest pitch of perfection," because of the beauty of its colouring, the litheness of its

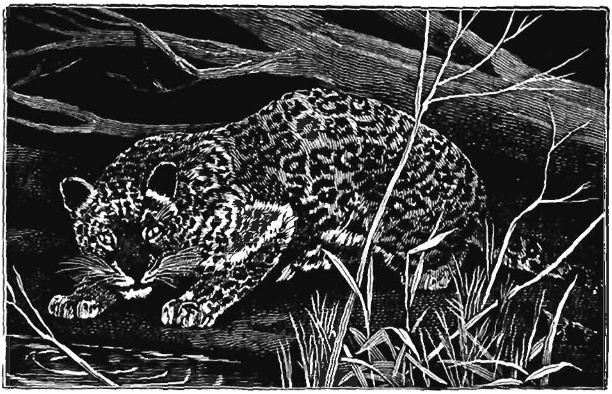


Fig. 25.—A Leopard.

body, and the agile grace of its movements. But it is savage and dangerous, and is much more dreaded than the lion or the tiger. It is as cunning as the tiger, but, unlike it, it is extremely bold. It lives chiefly in trees, and passes the daylight hours either concealed in a tree or in a cave, so that it is seldom seen. No domesticated animal comes amiss to it, and it will even rob a hen-roost. It follows its prey with great

persistence, and if disturbed after it has killed, it will run into any danger to recover its prey. One naturalist tells us that he frightened away a leopard that had come over a high courtyard wall and killed a sleeping goat. The body of the goat was taken indoors, and two hours later the leopard followed the trail of its victim into the naturalist's study.

On the Pampas or great plains of South America there are two great Cats—the jaguar and the puma—both now becoming comparatively scarce. The jaguar is very fierce, but does not attack man unprovoked. The puma is a terrible foe to cattle and especially to horses, and often kills not merely for food, but from sheer lust of killing. It is therefore hunted wherever it appears. Yet it never attacks man, and it is said even to show a certain friendliness for him. Many tales are told of huntsmen who have been forced to pass the night out on the plains, and have seen pumas come up quite close and play about without ever attempting to molest them.

There is an old story of a young girl belonging to a Mexican village, who was suspected of having gone out of the village one night to betray her friends. She was condemned by the chiefs of the village to be taken out on to the plains and left there for wild beasts to devour. Three days later

the heads of the village went out to the place where they had left the girl, and, to their surprise, found her quite unharmed. She told them that

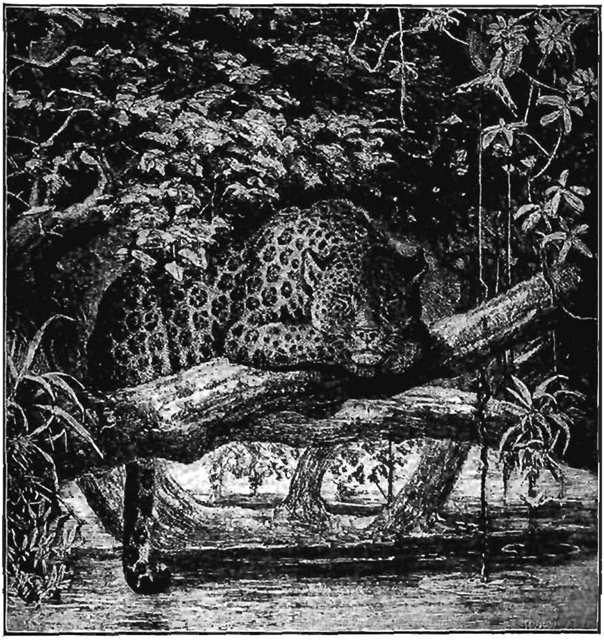


FIG. 26.—A Jaguar.
(From J. Wolf's *Life and Habits of Wild Animals*.)

the pumas had gathered about her, and not only did not attack her but fought off every other wild beast that came near. This was regarded as a sign of the maiden's innocence, and she was led back with honour and rejoicing to her home.

There are many other members of the Cat tribe, but we cannot consider them all. The only British representative of the family is the wild cat, which is still fairly well distributed throughout Europe. It was common all over Great Britain at one time, but is now found only in a few districts in the Scottish Highlands. Even there it is rapidly dying out, as it has been ruthlessly persecuted by gamekeepers on account of its destructiveness to game. Many reported wild cats are not true wild cats at all, but simply the descendants of domestic cats which have run wild, and have gone back to the hunting habits of their remote ancestors. The true wild cat is a larger animal, with more massive head and jaws. The tail is shorter than in the domestic cat, and is of the same thickness throughout, so that it looks as if the tip had been cut off.

Though the animals of the Dog family are individually less terrible than the Great Cats, the damage they do to man through his domestic animals is probably much greater. This is partly because they are more numerous, but mainly because many of them hunt in packs. When they are thus combined under the leadership of an experienced male, even the most timid among them becomes bold and pertinacious.

The jackal is a cowardly, slinking creature that

follows in the wake of the lion and tiger, to feed on the scraps they leave. But a pack of jackals is afraid of nothing. The pack will indeed break up before man, but the moment the actual danger is over it reassembles, and proceeds on its marauding way as boldly as ever. Jackals abound in most Eastern countries, and usually frequent the neighbourhood of villages and camps. They may do some service as scavengers, like their cousins, the half-wild pariah dogs, which are tolerated in Eastern towns because they eat up the refuse and decaying matter which is freely thrown on the streets, and the carcasses of dead animals, which are deposited just outside the city walls. But if the jackal really does any service in this way, it is far outweighed by its thieving propensities.

The Indian wild dog also hunts in small packs, and "when once a pack of them put up any animal, whether deer or tiger, its doom is sealed; they never leave it. They will dog their prey for days if need be, and run it down exhausted, and if it turns to fight, they go in fearlessly and their numbers win. All animals dread the wild dog; others they may elude by speed, artifice, or battle, but their instinct tells them there is no escaping the wild dog, as it hunts by scent as well as by sound, and it is as brave as it is persevering."

The Dingo or Australian wild dog was a terror

to settlers for many years. One colony is reported to have lost twelve hundred sheep within three months from the ravages of the dingo. It was therefore trapped, poisoned, and hunted in every possible way, and now it is becoming very rare.

The most formidable of all the Canine tribe

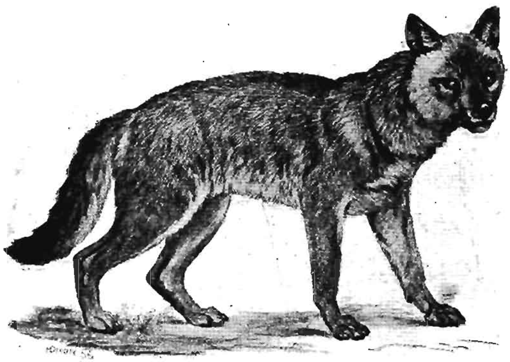


FIG. 27.—A Wild Dog.

is undoubtedly the wolf, and it is said that a single wolf is more dreaded by sheep-owners than a whole pack of jackals. A wolf will "leap the wall of a sheepfold and kill perhaps a quarter or a third of the flock, before his lust for slaughter is satisfied."

We are told that in one district a single wolf was responsible for the death of one thousand sheep, and in one part of Wallachia the wolves

devoured, *within two months,* thirty-one cows and three horses, and on one occasion killed thirty-five sheep in one night.

In winter in cold countries such as Lapland and Russia the wolves are half-starved, and they then assemble in large packs, "coming to the very walls of St. Petersburg." Such packs follow their

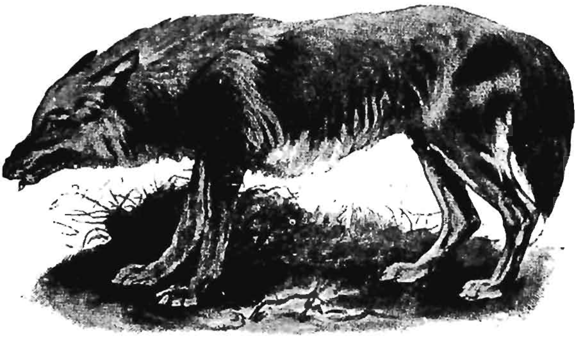


Fig. 28.—A Wolf.

prey with the same relentless persistence as the Indian wild dog, stopping only to devour those of their own number that have fallen by the way.

Wolves followed Napoleon's army on the retreat from Moscow, and so were reintroduced into parts of Europe in which they had become scarce. We are told that a pack of wolves fell upon and overpowered a party of twenty-four *armed* French soldiers (1812), and although two hundred dead

wolves were found on the field not a single soldier escaped.

Wolves lingered on in England till towards the end of the fifteenth century, and in Scotland till early in the seventeenth, if not later. In Wales they were exterminated at a comparatively early date, for that country was compelled to pay to the English king, Edgar (A.D. 965), a tax of three hundred wolves annually. After this had been paid for two years the supply was exhausted, and Wales was thus freed at once from her tax and her wolves.

But throughout the rest of the country the ravages of these voracious beasts in winter were so terrible that January was called the "wolf's month." All possible means were taken to root them out; they were hunted and trapped on every opportunity. But as long as the forest remained the wolves remained too.

It was only as the land was cleared for cultivation that the wolves were driven northwards, and finally exterminated. In some districts in Scotland the dead were buried in coffins made of flagstones to prevent the wolves digging them up. In many parts of the Highlands stories are still told of among the people of encounters with wolves. One of the latest and best known of these is of a woman who went some distance to borrow a

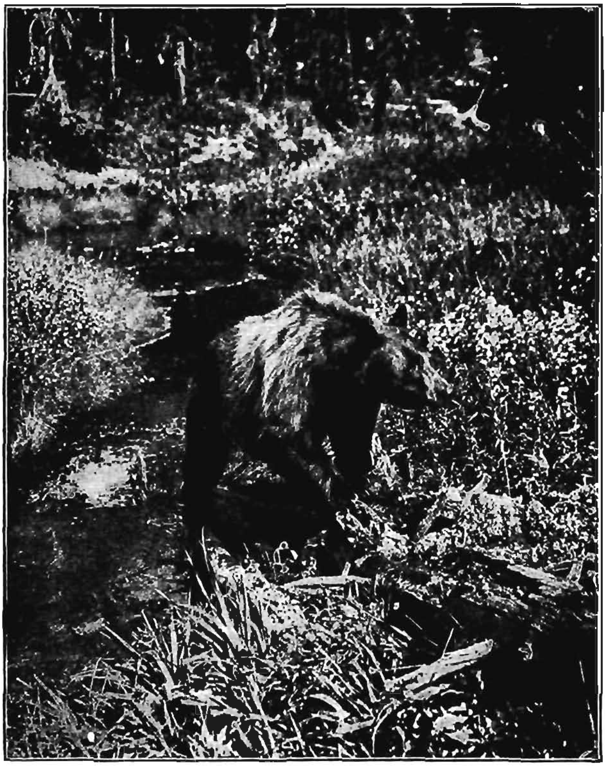
"girdle," a heavy iron baking-plate with a handle. On her way home she sat down on a stone to enjoy a quiet chat with a friend, when she was startled by a scraping noise in the leaves beside her. Looking round she saw a wolf glaring at her with greedy eyes, and preparing to spring. Coolly she lifted her heavy girdle and struck him such a blow on the head with its sharp edge that he fell dead on the spot.

The last wolf in the Lochaber district was killed by Sir Ewen Cameron in 1680, but there is a legend that a wolf was killed in Sutherlandshire so late as 1743.

The only wild member of the Canine tribe now left to us is the fox; and it is not likely that it would have remained so long if it were not that it is strictly preserved for sport. The fox eats all kinds of animals that it can kill, but at most times mice form the staple of its diet. When the young have to be provided for, the mother hunts larger game—aquatic birds, domestic fowls, hares, rabbits, and the like, and she uses in her quest all the cunning with which foxes have been credited in song and story from the earliest times.

The bear must be reckoned among the animals that are dangerous to man, although they are not by any means exclusively carnivorous. The Polar or Ice bear lives mainly on seal flesh and on fish,

and is a dangerous foe to meet, but he does not often attack man unprovoked. The huge grizzly



Photo—Underwood and Underwood.

FIG. 29.—Brown Bear tearing open a decayed tree-trunk to obtain the grubs.

bear of the Rocky Mountains, too, is chiefly a flesh eater, and kills deer and even the great bison with-

out difficulty. It does terrible havoc among cattle and horses, and for this reason is frequently poisoned by the ranch holders. It will attack man readily, sometimes, it is said, without provocation, and its great strength makes it a most formidable antagonist. Hunting grizzly bears is looked on as one of the most exciting forms of sport, and they are now decreasing in numbers.

The common brown bear is found in North America, Asia, and in almost every part of Europe which affords the conditions necessary to its existence—a moderately cold climate, a continuous stretch of inaccessible or at least little disturbed forest, and a plentiful supply of food. He is omnivorous in the fullest sense of the word, that is, will eat almost anything. His staple food is roots, fruits, and the like, but at all times he eats worms, insects and their larvæ, eggs, and fish. In fact he eats whatever he can get at each season. It is in early spring, when he emerges hungry from his long winter sleep, that he is most dangerous. The snow has not all disappeared, there are no fruits and few small animals to be found, and the bear in his hunger attacks sheep and goats, and has been said even to kill cattle in a cowshed.

It is usual to think of the bear as a rather lazy and good-natured animal, with a certain sense of humour! But a German naturalist declares that

this last character has been attributed to it rather from the drollness of its gait than from anything in its moral nature. It is indifferent rather than good-natured, and if provoked is capable of fits of ungovernable and frantic rage. It usually avoids man, but if wounded or attacked by him it fights savagely. A mother bear that has lost her whelps will avenge them without the smallest concern for her own safety.

Bears were at one time quite common in Britain, but that was very long ago. There is very little mention of bears after the fifth century, but it is believed that a few lingered on in the inaccessible, rocky forests till about the tenth. The Romans indulged in the cruel sport of bear-baiting, and it was practised till a comparatively late period, for we read that the town of Norwich, in the time of Edward the Confessor (1022), was forced to furnish annually "one live bear, and six dogs for baiting the same." But foreign bears were imported long after the native ones had been killed off, or had died out, and it may have been with an imported bear that this tax was paid.

Earlier still, before history began, bears were quite common all over Britain. We learn of this by what is called cave-hunting, for our earliest ancestors were fond of caves and so were wild animals. So, by exploring caves and working at the

remains found on the floors of them, it has been possible to make quite a trustworthy picture of the life of man before there was any written history.

Man used the caves as homes, as refuges, and as tombs, and in them we find the bones of the animals which he ate, or of those which he petted and domesticated. Other animals, too, found their way in, some falling in by mischance, some seeking safe and comfortable retreats. Huddled into corners, trodden into the floor, or petrified by the slow drip of limy water, the remains have been left to tell their tale to us.

It is, of course, too long a story to tell, but one of the general results is this, that prehistoric man in Britain had for his rivals, or companions, as the case may be, such animals as the cave-hyæna and the cave-lion, the cave-bear and the grizzly, the huge shaggy mammoth and the woolly rhinoceros, the wild ox and the horse, the wolf and the fox, the elk and the reindeer.

Many caves have been explored in which the remains of these animals and many others are so mixed up that there can be no doubt that they were all living in the country at the same time. It is certain that man was in the midst of them; and surely it is only grateful to try to picture how our early ancestors, without any of our modern devices, held their own against fearful odds, gaining through

their struggles a hardihood, a wisdom, and a gentleness, some of which is part of our inheritance to-day.

CHAPTER VI

ANIMALS WHICH DESTROY MAN'S CROPS

To the great Carnivores, or flesh-eating animals, which are dangerous to man and to his flocks, we must add as man's rivals in the struggle for existence many animals which devour or destroy his crops. Some of these are so large, and have such enormous strength, that they also are dangerous to man himself.

We immediately think of three of these—the hippopotamus, the rhinoceros, and the elephant.

The hippopotamus used to be common "on every lake and river throughout the African Continent, from the delta of the Nile to near Cape Town," but it is not now found below Khartoum, and it is rare south of the Zambesi. Where water-plants such as the lotus, which is its favourite food, are abundant, the hippopotamus rarely leaves the water at all. In that case he is hardly to be looked on as a rival to man, but may indeed be of some service to him by keeping clear the slow-flowing waters, and the forest-pools, which would

otherwise become swamps. But it is different where water-plants are scarce.

The hippopotamus spends the whole day in the river, but at dusk he becomes more active, and sets forth on a foraging expedition. All kinds of grain and all kinds of vegetables are devoured. Water-melons are said to be particular favourites, and the

Fig. 30.—Hippopotami fighting. About 5 feet high and 11 feet long.

largest of them only makes a single bite. It is not only what he devours that is lost to man; he destroys an enormous amount of growing grain by trampling it down with his ponderous hoofs. The natives light fires all along the river banks, and they watch by these, and keep up a constant beating of drums and shouting throughout the night. But it is not easy to scare away a hippopotamus from his favourite food.

There are several kinds of rhinoceros, some living in the African forests, others in different parts of Asia. Most of them inhabit fairly high and dry ground, often hilly forests. They do not eat grass, but browse on the leaves and young shoots of trees and especially, it is said, of thorny bushes.

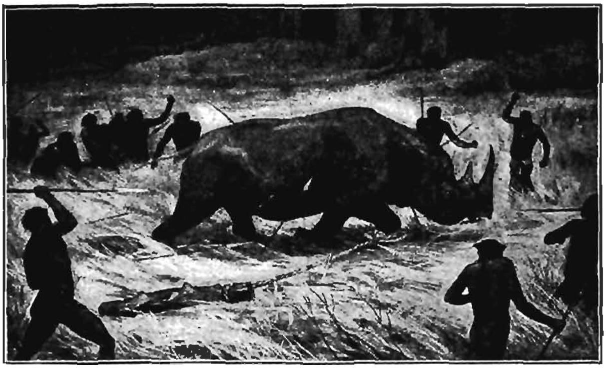


FIG. 31.—Rhinoceros caught in a snare. About 5 feet 10 inches high and 12 feet long.

Like the hippopotamus they do great damage among cultivated fields.

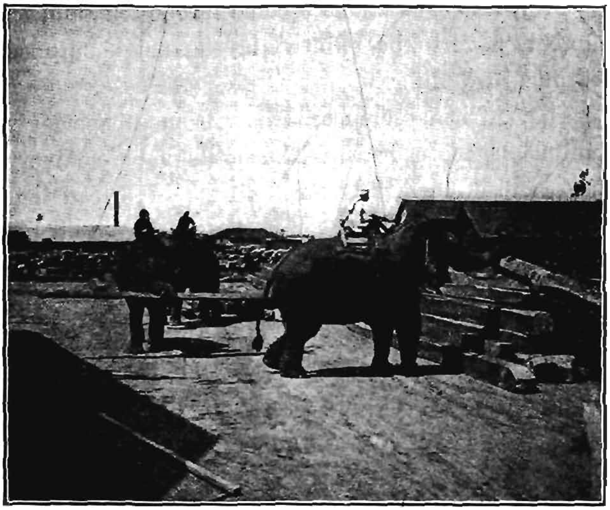
The rhinoceros is usually timid and inoffensive, and keeps out of the way of man. But if pursued and wounded it becomes very dangerous. Occasionally, too, a rhinoceros has been known to attack without provocation. But we can hardly wonder that, when man invades the forest solitudes where these great beasts and their ancestors have roamed

undisturbed for ages, the rhinoceros should sometimes rush in frantic fury on a caravan and disperse it in all directions, or the hippopotamus wildly charge a boat and upset it with a toss of its mighty head, or crunch the stern of a little river steamer in its jaws.

In its wild state even the Indian elephant must be looked on as one of man's rivals, for it, too, can work terrible havoc among his crops. The natives erect a strong platform about fifteen feet high beside their rice-fields, and two of them keep watch by turns all night for the approach of the marauders. As soon as there is any sign of elephants the watching native rouses his comrade and both shout, beat drums, and make all sorts of noises to scare the intruders away. A herd is generally easily kept off by such means, or by a slight fence, or a pitfall, but a solitary and experienced old bull elephant has generally found out the feebleness of such defences, and will roam at pleasure through the rice-fields, or tear up the young plantations of sugar-cane.

It is said that elephants will, in sheer wanton mischief, destroy a great part of the work that man has done through the day, tearing down buildings, pulling up fences, and so on. But man has learnt to turn the strength of the Indian elephant to his own service. It has not, indeed, become a domesticated animal in the true sense of the term, for it will not bring forth its young in captivity, so

that fresh wild elephants have to be continually caught and trained. When caught, the elephant makes a willing and effective servant, and much of the opening up of India was due to its help. It was used for piling timber, bridge-building, and



Photo—Underwood and Underwood.

FIG. 32.—Elephants piling timber.

road-making, but where the roads and railways run much of the elephant's former work is now done by steam machinery. Yet for transporting merchandise across rough or soft country, and especially for rooting up bushes and trees, and clearing the jungle for the making of tea-gardens, the elephant remains without a rival.

Because of its usefulness the Indian wild elephant enjoys a certain measure of protection, for the numbers caught every year for Government service, or for the State pageants of the native princes, is comparatively insignificant. Sometimes, however, its devastations become intolerable, and its numbers have to be reduced in the neighbourhood of human dwellings.

The African elephant has been unsparingly hunted for years for the sake of its valuable ivory tusks, and often merely for "sport." We read that on one occasion no fewer than one hundred and four African elephants were destroyed at once. This was a dismal butchery, but one may safely say that it will never occur again. Partly, we may hope, because we are beginning to recognise the rights of the wild creatures, but also because wild life is becoming ever scarcer. We have only to listen to the stories travellers tell us of their sport in the wilder parts of the world, to be convinced of the gradual disappearance of many noble animals. There is no doubt that man is the worst enemy of wild nature.

In 1893, Selous, a true sportsman to whom we owe much of our knowledge of the large African wild animals, wrote: "To the best of my belief, the great white or square-mouthed rhinoceros, the largest of modern terrestrial animals after the elephant, will in the next few years become

absolutely extinct." Yet "twenty years ago it was a common animal over an enormous extent of country in Central South Africa."

It is the same with the hippopotamus. When it had only to contend with the snares of the Soudanese, or the treacherous pitfalls of the Kafirs, it held its own, snorting and bellowing, happy and fearless as of yore. But against the deadly weapons of civilisation it is utterly defenceless, and in the neighbourhood of settlements it has become timid and cautious, showing only its nostrils above the water, breathing quietly, and disappearing again. Yet, sad as is the extermination of so many noble animals, it is not easy to see how it is to be avoided. We may, indeed, postpone the fatal end if we refrain from *unnecessary* killing, from killing not for food, or for the protection of human life, or of crops, but simply for the sake of killing. Yet it is to be feared that the doom of these great beasts is inevitable.

The human race is spreading and colonising everywhere, and as it spreads the wild things retreat before it. Dense forest offers very little for the support of human life, and as man spreads he clears away the forest around him by axe or fire, and tills the ground that it may bear food for himself and for the animals which serve him. But these great beasts, as Brehm said, were created for the wilder-

ness; it is impossible that man and they should remain as rivals. Man, by reason of the intelligence which has enabled him to make up for his own lack of strength by inventing deadly weapons, must remain the victor in the struggle. But we must agree sadly with Selous, that as the world becomes more civilised it becomes less interesting.

Among the less formidable but very troublesome rivals of man in warm countries we must reckon the monkeys. In India monkeys are held in great respect, and no Hindu will kill one, or suffer it to be killed, however thievish it may be. Round some of the temples, groves of fig-trees sacred to the monkeys are planted, and when the figs are ripe troops of Macaques and Langurs come from the jungle to feast on them. This would be all very well if the monkeys would keep to their trees, but they steal the grain from every field and the fruit from every garden on their way, and the natives can only look helplessly on. They may be scared away for a little, but they are in no fear of their lives, and return again and again. "Nor," writes Mr. Lockwood Kipling, "is it only in field and garden that their depredations are felt. Indian shops have no doors or windows, but are like large cupboards open to the street, in which food grains and other articles are exposed for sale; and in towns where Hindus preponderate and a busy

current of trade has not swept the streets, bulls, calves, parrakeets, and monkeys take toll which the dealer would fain prevent, but that he is few and fat, while the depredators are many and active. A stout grocer nodding among his store-baskets while a monkey, intently watching the sleeper's face, rapidly stuffs his cheek-pouches with grain, is a common sight, as well as a comical one."

In one town where the monkeys' constant pilferings had become an intolerable nuisance, an ingenious device for getting rid of them was adopted. No monkey might be killed or injured, but they might be caught and transported. So as many as possible were caught, caged, and sent in bullock-waggons to a place many miles distant, and there set free. "But as the empty carts returned, the monkeys, quick to perceive and defeat the plan of their enemies, bounded gaily alongside, and trooped in through the city gates with the air of a holiday party returning from a picnic."

In South America, too, "whenever the golden orange glows among the dark foliage of the plantations, the Capuchin monkeys make their appearance to share the fruit with its owners."

Brehm, whose journeys in search of knowledge took him into the deserts and forests of Africa, as well as into the ice-bound wastes of Northern Asia, tells us of the difficulties of agriculture in some

parts of Africa, because of the monkeys. "We sow, and the monkeys reap," said the people to him sadly, and when he got to know the ways of the monkey, he realised that it was very often true. Nothing edible comes amiss to them. "Here a ripening ear is broken off, there a juicy fruit is gathered, in the tree a bird's nest is plundered, on the ground a stone is turned over, in a settlement a garden is stripped or a field robbed, and something is carried away from all. If he has time, every single monkey destroys ten times as much as he eats, and can therefore very materially damage the produce of the farmer, gardener, or fruit-grower. At the beginning of an expedition each monkey, in his anxiety to secure himself a meal whatever may happen, devours almost indiscriminately whatever he can reach; then, if he possesses cheek-pouches, he stuffs these as full as possible, but as soon as his most pressing necessities are relieved he selects and criticises every bite, carefully examining and smelling every fruit he plucks, every ear he breaks before eating it, and, indeed, in most cases simply throwing one thing after another away to seize something different which is rejected in its turn."

We have already referred to the herds of deer and wild pig that swarm in the Indian jungles. The pigs are particularly troublesome, for they not only tear down branches, and trample down young

trees and growing grain, but they plough up great stretches of ground with their snouts, in their search for the roots and tubers which are their favourite food. The tiger helps to keep their numbers within bounds in India; and in colder countries, wolf, fox, and lynx, though they will not venture to attack a full-grown animal, levy a constant toll on the piglings. But there are so many piglings in a litter, and they grow up so quickly, that the number of wild swine in any suitable locality, such as a swampy forest, is apt to be very great. These animals have a special interest for us because of their abundance in our own country in earlier times.

Many of the vast forests of Old England consisted largely of great oak and beech trees, and the acorns and beechmast which these produced formed the chief food of the numerous wild swine which inhabited the forests. The wild boar was one of our earliest historic wild animals, and boar-hunting was the favourite sport of Britons, Romans, Saxons and Normans in turn; and a right noble sport it must have been, if difficulty and danger be the test! For a big, powerful wild boar, measuring perhaps four feet in length, is no contemptible foe; his tough hide, with its thick, strong bristles, protects him well, and he possesses most formidable weapons in his strong, sharp lower canine teeth or tusks.

An old writer on hunting tells us that a dog once struck by a boar never recovered, that one could kill six or seven dogs "in the twinkling of an eye," and that, of a pack of fifty good hounds which attacked a single boar, not twelve returned to their master alive and sound. The same writer instructs huntsmen to strike high, for if a blow be

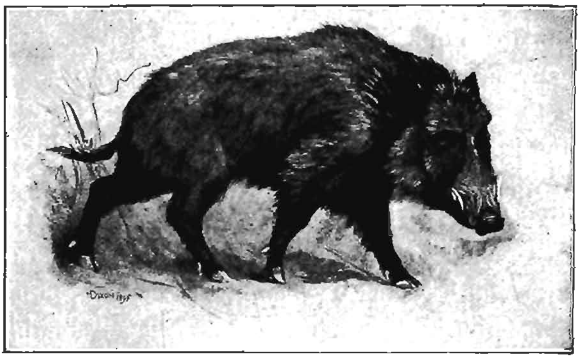


FIG. 33.—Wild Boar, about four feet long.

aimed too low the boar will parry it with his tusks, and to be careful not to strike towards their horses, as the wounded animal turns at once to the side on which he is hurt, and might thus kill the horse, and have the rider at his mercy.

After the repeal of the Forest Laws, boars were killed unsparingly whenever possible, and they became gradually rarer until the seventeenth century, when, if a boar's head still graced the

English baron's Christmas table, it was certainly not procured from the forests around his castle.

Various attempts have been made to reintroduce the wild boar into England, but without success. Evelyn, writing in the seventeenth century, says that he sent a Portugal boar and sow to Wotton, "but they digged the ground so up and did such spoyle, that the people would not endure it"; but, he adds, "they made incomparable bacon."

Another interesting forest dweller, with which our ancestors had to contend, was the white wild ox, or Auerochs, as it is called. The wild ox, which Cæsar, who saw it in Germany, describes as "little inferior in size to an elephant, but a bull in colour and figure," is believed to have survived, in some parts of Britain at least, till about the fifteenth century. There are abundant fossil remains of it, showing that it must have been quite common in the early days of man in Britain, but there are also many references to it in history. To this day stories are told in the Highlands of a "white water-bull" that lived his lonely life in the depths of the forest, and wallowed in the dark waters of the hidden tarn.

The densest and wildest forest of which we have record—the great Caledonian forest, which covered the whole vale of Athole—is described as "dreadful for its dark, intricate windings, its dens

of bears, and huge, wild, thick-maned bulls." Another old historian gives us more details about the bulls. "In the Caledonian forest," he wrote, "were sometime white bulls, with crisp and curling manes like fierce lions, and though they seemed meek in the remanent of their bodies, they were

FIG. 34.—Wild White Ox.

more wild than any other beasts. . . . They were so wily that they were never taken but by sleight and crafty labour, and so impatient that after they were taken they died of insupportable dolour."

But the Caledonian forest has long been gone, and with it went the wild ox, the wild boar, and the wolf. Perhaps we cannot be altogether sorry,

so far as these creatures are concerned, for though life without them may be less interesting it is undoubtedly more comfortable. So we need not grieve too much over what we have lost in the past, but rather study how we may best care for what is left to us; and that is a great deal. "There is a frontier-line to civilisation in this country still, and not far outside its great centres we come quickly even now on the borderland of nature. Modern progress, except where it has exterminated them, has scarcely touched the habits of bird or animal; so almost up to the very houses of the metropolis, the nightingale yearly returns to her former haunts. If we go a few hours' journey only, and then step just beyond the highway—where the steam-ploughing engine has left the mark of its wide wheels upon the dust—and glance into the hedge-rows, the copse, or stream, there are Nature's children as unrestrained in their wild, free life as they were in the veritable backwoods of primitive England."

These words were written by a keen-eyed lover of nature more than twenty years ago, but they are equally true now. Wild nature lies all about us still, but we must have eyes to see it.

CHAPTER VII

THE BALANCE OF NATURE

ALTHOUGH the struggle with the larger wild animals is at end so far as most European countries are concerned, and is everywhere becoming less keen, man is still far from having things all his own way. Nature's children are about us everywhere, and they have to get their living where and how they can. Let us read a fine description of what the writer of it calls the "war with nature," when man breaks new ground in a country like South America. We must not forget, however, *that, if there is really war with nature*, man is usually the aggressor in the fight.

"A thousand strange tricks and surprises will she invent to molest him. In a hundred forms she will buzz in his ears, and prick his flesh with stings; she will sicken him with the perfume of flowers, and poison him with sweet honey; and when he lies down to rest she will startle him with the sudden apparition of a pair of lidless eyes, and a flickering, forked tongue. He scatters the seed, and when he looks for the green heads to appear, the earth opens and lo, an army of long-faced, yellow grasshoppers come forth! She too, walking invisible by his side,

had scattered her miraculous seed along with his. He will not be beaten by her, he slays her striped and spotted creatures; he dries up her marshes; he consumes her prairies and forests with fire, and her wild things perish in myriads; he covers her plains with herds of cattle and waving fields of corn, and orchards of fruit-bearing trees. . . . She is hard pressed and cries to her children that love her to come and deliver her. Nor are they slow to hear. From north and south, from east and west, they come in armies of creeping things and in clouds that darken the air. Mice and crickets swarm in the fields; a thousand insolent birds pull his scarecrows to pieces, and carry off the straw stuffing to build their nests; every green thing is devoured, the trees, stripped of their bark, stand like great white skeletons in the bare desolate fields, cracked and scorched by the pitiless sun.

"When he is in despair, deliverance comes; famine falls on the mighty hosts of his enemies, they devour each other and perish utterly. Still he lives to lament his loss, to strive, still unsubdued and resolute. She too laments her lost children, which now, being dead, serve only to fertilise the soil, and give fresh strength to her implacable enemy. And she too is unsubdued; she dries her tears and laughs again; she has found out a new weapon it will take him long to wrest from her hands. Out of many

little humble plants she fashions the mighty noxious weeds; they spring up in his footsteps, following him everywhere, possessing his fields like parasites, sucking up their moisture and killing their fertility. Everywhere, as if by a miracle, is spread a mantle of the rich, green, noisome leaves, and the corn is

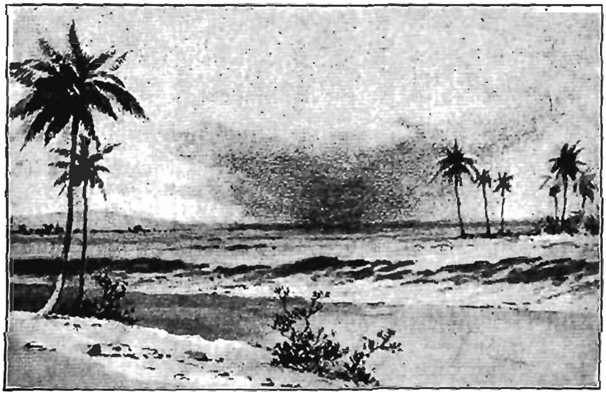


FIG. 35.—Flight of Locusts.

smothered in beautiful flowers that yield only bitter seed and poison fruit. He may cut them down in the morning; in the night time they will grow again."

One of the most terrible enemies with which the tiller of the soil has to contend in many countries is the locust. We read of the locust in the Old Testament as one of the plagues of Egypt. "They covered the face of the whole earth, so that the land was darkened; and they did eat every herb of the

land, and the fruit of the trees which the hail had left; and there remained not any green thing in the trees, or in the herbs of the field, through all the land of Egypt."

The locusts are insects related to our grasshoppers, but much larger and more voracious. Their bodies are light, and they are easily borne along by

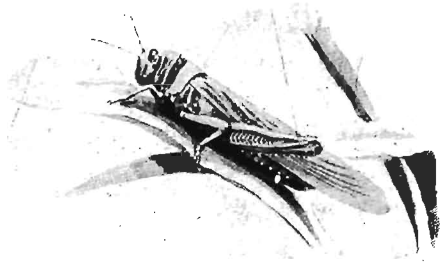


FIG. 36.—Locust.

the wind with very little exertion on their own part. Wherever they are resident they do a great deal of damage every year, but it is the sudden swarms of migratory locusts which are such a dreaded scourge. For several favourable seasons they may have been increasing in numbers, and then, one year, the supply of food is insufficient. Then swarm unites with swarm till vast hordes are formed, which may walk or fly for long distances, blighting every green thing in their path.

These migrations may occur at any stage, those of the young wingless insects—"hoppers" as they are often called—being almost as much dreaded as those of the mature insect. Steadily these young insects, perhaps only a few days old when they start, keep straight on, turning aside for no obstacle. Ditches may be dug across their path, fires lighted in their way, but the ditches are filled up and the fires extinguished by the first-comers, and the vast army behind pushes steadily on over their dead bodies. When the army is not too large, a deep moat and abundance of poisonous spray may serve to avert disaster.

When a winged horde makes its appearance in a district every attempt is made to scare it away from the more valuable crops. Horsemen ride among them, fires are kindled, drums beaten, and flags waved, but all to little purpose.

They make their appearance so suddenly, and complete their work of destruction with such incredible swiftness, that it is almost impossible to save any crop on which they have settled. We read of an American tobacco-grower who planted forty thousand young tobacco plants near his house that he might watch them continually. A cloud of locusts darkened the sky, he rushed out, the black swarm settled on his crop, and in *twenty seconds* not a leaf remained.

Towards the end of summer the army begins to break up. Disease thins its ranks, birds prey upon them, and they may disappear completely from a whole country for a time. But some of them have somewhere in the course of their wanderings deposited their last eggs. These lie dormant throughout the winter, and in the following spring thousands of young locusts will burst forth to ravage the slowly recovering land once more. But the numbers will not be nearly so large for some time. A sudden great increase in one kind of animal is usually accompanied by an increase in animals that prey upon it, or the available food-supply is exhausted, and famine and disease reduce the species so far below its ordinary number that it may be several years before the average is reached again.

Brehm tells us of a locust swarm that made its appearance on the belt of green round a lake in the African forest, where many birds pass the winter. "From far and near they come flocking, falcons and owls, ravens and rollers, francolins and guinea-fowl, storks and ibises, coots and ducks. Every bird that ever eats insects now confines itself exclusively to the pertinacious visitors. Hundreds of kestrels and lesser kestrels, which are then in these winter quarters, sweep over the invaded forest, and swoop down upon the locusts, seizing and devouring them with scarce an interruption in their flight. Ravens,

rollers, hornbills, ibises, and storks pick them off the branches of the trees, and shake down hundreds which fall victims to the guinea-fowl, ducks, and other birds waiting underneath."

But there are many left. It is *only* man who exterminates. In natural conditions there is "a natural law of consumption and supply" which keeps the balance even, ensures the continuance of all Nature's children, and yet allows none of them to usurp more than its own place in the web of life. A few examples will help us to understand this.

One summer on the pampas of South America a "wave of life" was observed. The summer season was a bright one, but with many scattered showers. The first result of this unusual moisture was that the wild flowers did not dry up and wither at the first touch of heat, but remained in bloom throughout the summer months. With the flowers came an unusual number of their visitors the humble bees. The bees were followed by extraordinary numbers of mice, for the season was a favourable one for them also, and the bees provided them with abundant food. The mice increased at a rapid rate, till towards the end of summer "the earth so teemed with them that one could scarcely walk anywhere without treading on mice; while out of every hollow weed-stalk lying on the ground dozens could be shaken."

The dogs pursued the mice continually, the domestic cats left the houses and spent their whole time hunting them; even the fowls became birds of prey for the time. Soon new hosts appeared. Storks and short-eared owls arrived in great and unusual numbers, and they, too, fed sumptuously. The humble bees were all devoured or driven out by the mice long before the end of summer, but the owls stayed on, bred in the middle of winter, and reared their young at the expense of the mice, so that when spring came "it was hard to find a survivor, even in the barns and houses." The first result of the unusual increase in the number of mice was an unusual reduction; but in a short time that would be made good again, and the balance of nature restored.

A similar case occurred a good many years ago in our own country. For a couple of seasons (1892-93) there was a serious plague of field-voles in the south of Scotland. The field-vole, or short-tailed field-mouse, as it is sometimes called, is one of the worst enemies of the farmer. It eats vegetable food only, and requires a great deal of it. Among the things for which it shows special fondness are seeds, grass, herbs, roots, and leaves; clover, fruits, and berries; beechmast, corn, turnips, and potatoes. "When the corn begins to ripen, they assemble in hordes in the fields, bite the

stalks through at the base till they fall over, then gnaw them through above, and drag the ears into their burrows. During the harvest they follow the steps of the reapers from one field to another, devour the corn that has fallen among the stubble, and gather the ears that have fallen in binding up the sheaves, and at last find their way to the stack-yard, where they find provision for the winter." All sorts of devices were tried to cope with the plague, but with small success. The grass over thousands of acres was bitten through, and what was left was quite worthless, so the sheep suffered severely.

FIG. 37.—Field-Vole, about 4½ inches in length, with a tail 1¼ inches long.

But Nature did not long allow the voles to flourish undisturbed. There were others of her children to be fed. So the birds of prey arrived, the hawks, the buzzards, and the owls. The short-eared owls, of which only a few pairs are ordinarily found in the district, came in numbers, and four hundred nests were counted. Moreover, the number of eggs laid in each nest was, thanks

to rich feeding, greater than usual. The young owls are voracious creatures, but it was easy to satisfy their wants. The voles diminished rapidly; those that remained grew sickly and feeble, and at the end of the second summer they had almost entirely disappeared.

There can be no doubt that a good many of the difficulties that man has to contend with are due to the fact that, by his own actions, he thoughtlessly or unconsciously disturbs the balance of nature. A sudden plague of voles will attract numerous birds of prey from other regions. But the increase of the voles in a district may be mainly due to the constant killing off of their natural enemies. These birds have been shot for generations by almost every gamekeeper because *some of them* eat young game birds. But we may buy our grouse and partridges too dear, if, in killing off the birds that thin the young ones, we also kill off the natural enemies that keep the destructive voles and mice in check.

In order to be able to foresee the consequences of making war upon any kind of animal, we must know something about the way in which the animal lives, and with what other animals or plants the thread of its life is bound up. Thus, for instance, there is a little mouse-like animal, the shrew, which is killed indiscriminately by the farmer along with the voles and mice. But the shrew has quite

different habits. It does no harm whatever to the farmer, but renders him great service, since it is carnivorous and feeds on beetles and grubs which do much harm to growing roots and crops. It also "kills more voles in a year than the farmer himself."

Nor is it wise to slaughter the birds that eat our cherries and peck holes in our strawberries. For they, too, are only taking their lawful reward for the services they do us in picking off the little grubs and the scale-insects that injure our trees.

"Avaricious, blind indeed who proscribes the birds—those destroyers of insects, those defenders of his harvests. Not a grain for the creature which, during the rains of winter, hunts the future insect, finds out the nests of the larvæ, examines, turns over every leaf, and destroys every day thousands of incipient caterpillars. But sacks of corn for the mature insect, whole fields for the grasshopper which the bird would have made war on. With eyes fixed upon the furrow, upon the present moment only, without seeing and without foreseeing, blind to the great harmony which is never broken with impunity, he has everywhere demanded or approved laws for the extermination of that necessary ally of his toil—the insectivorous bird. And the insect has well avenged the bird." . . . "In the Isle of Bourbon, for instance, a price was set on the head of the

martin; it disappeared, and the grasshoppers took possession of the island, devouring, withering, scorching with blighting breath all that they do not consume."

This was written many years ago by an enthusiastic French bird-lover, but the warning is not unnecessary even now. It is our own fault now, however, if we do not know what we are risking when we shoot the birds from our garden and fields. For a great deal of scientific work has been done within the last few years, with the object of determining definitely which birds are to be looked on as man's friends and which as his enemies, or rather rivals. The result is, that a long list has been drawn up of birds which are wholly useful to man because they feed entirely on insects and grubs; a shorter list, including the song-thrush and other favourites, of those which do a good deal of harm, but more than make up for it by the good they do; and a very short list indeed of those for whom there is not a good word to be said from the point of view of the farmer and gardener. This last list includes the wood-pigeon and the house-sparrow.

The fashion of wearing beautiful feathers for decoration is also responsible for the diminution, and probably the ultimate extermination of many rare and wonderful birds, and we cannot foresee what consequences this disturbing of the balance

of nature may have where these species are killed off.

Introducing the animals of one region into another where the conditions of life are quite different, is another way in which man sometimes disturbs the balance of nature, and makes trouble for himself. Sometimes an animal fits into the new conditions and is of service, but it is never easy to foresee what may happen.

Sparrows were introduced into the United States about fifty years ago, in the hope that they would multiply sufficiently to be of use in keeping down the numbers of the insects which were destructive to fruit and grain. The sparrows throve exceedingly in the new conditions; but the grain was easier to get, and more to their taste than the insects which destroyed it. These, however, were very useful for feeding the young ones, which grew fast and vigorously, so that by harvest time they were ready to do their share in plundering the fields with the rest. Now sparrows are so numerous in the States that they have become quite a plague, and very expensive measures are continually being taken to reduce their numbers.

Rabbits were taken to New Zealand and to Australia to add to the food-supply of these countries. But the dingoes, which would have kept the rabbits within due bounds, had been

almost killed off because of the damage they did to the sheep, and the rabbits increased to such enormous numbers that they are now a source of serious expense to the colonists, who have to fence in their fields to protect their crops. Every effort has been made to get rid of them again, but so far

Photo—Charles Reid

FIG. 38.—Wild Rabbits.

without much success. Poisoning and introducing infectious disease among them have been suggested, but men are growing wiser about interfering with nature, and are unwilling to take measures like these, since they cannot be certain that their effects would be confined to the rabbits alone, and would not extend to the sheep on which so much of the prosperity of the country depends.

Several millions of frozen rabbits are now ex-

ported from New Zealand every year, and though there must be some satisfaction in turning the tables on the rabbits in this way, the profit gained will go a very small way to make up for the loss they cause by nibbling the growing crops.

Many animals and plants are transferred from one country to another by man's agency, but without any intention on his part. Insects, for instance, are very often transported among cultivated plants, and among merchandise carried in ships. In the earlier stages of their life, especially, insects have often the power of lying dormant for a considerable time, and then awakening to fresh life and full development when the conditions become favourable. Thus eggs, larvæ, or pupæ may be carried long distances by ship or rail, and on reaching new soil where the climate is favourable to them, and where the natural enemies which prey upon them are absent, they may multiply rapidly and cause serious damage, though in their original home their presence may hardly have made itself felt.

Let us take one more illustration of the way in which man may disturb the balance of nature, and bring about consequences he could hardly have foreseen. The cutting down of the forests was "Man's first violation of nature," his first interference with the harmony of things. As we have already seen, the clearing of the forest was to some

extent unavoidable, as more soil was required for growing grain and fruit-bearing trees. The first result of this clearing of the ground was to hurry on the extermination of many animals, both harmful and beneficial to man. Another result was to drain flat, swampy country and make it healthier. This was the case in many parts of England, for instance, where ague was prevalent until the clearing of the land dried up the swamps.

But, unfortunately, the clearing was carried on without either knowledge or forethought. If it had been restricted to the low-lying lands, or if belts of woodland had been left undisturbed, no serious harm might have resulted. But as time went on, as ships were built, and weapons manufactured, the timber on the hill-sides was recklessly cut down for building purposes, for domestic fuel, above all for fuel for the furnaces necessary in the smelting of iron for weapons and machinery, with no thought for the needs of future generations.

The effects of this reckless cutting are most seen in some of the countries of Southern Europe, where the hills were stripped of every tree, with very serious consequences. The hill-sides became dry and bare; scorching winds swept untempered over the once fertile valleys, the heavy rains, no longer absorbed by a soft carpet of vegetable mould, or sucked up by the roots of the trees, washed

down the hill-side in devastating torrents, carrying away fertile soil, so that the inhabitants were obliged to desert the desolated fields from which they could no longer wrest a living.

CHAPTER VIII

PASTEUR AND HIS WORK

WE have to consider one other phase of the struggle between man and animals—the struggle with parasites.

Parasites are living creatures which live at the expense of other living creatures—either animals or plants—drawing all their nourishment from the body of their "host." Some parasites belong to the animal world, others to the plant world. They may attack man, animals, or plants, and may spend their life with a single host, on or in which they live as welcome or unwelcome guests, or they may require two or more of different kinds in order to go through the different stages of their life-history. Scarcely any animal is free from parasites of one kind or another, but the amount of trouble to which they may give rise varies greatly. Some parasites cause only a temporary annoyance, others a more permanent but still comparatively slight incon-

venience to which the host readily adapts itself, while others again may cause very serious or even fatal illness.

Members of many groups of animals have become parasitic in habit, and later we shall learn something of their way of life and its consequences. But here we must confine ourselves to the story of one parasitic organism, the way in which it was discovered, and what the discovery led to.

We have already mentioned the silk-worm as a domesticated animal; let us now learn something of its life-history.

The eggs of the silk-moth are laid on the caterpillar's food-plant, usually the mulberry tree, and they generally lie through the winter and hatch out in spring. The tiny caterpillars feed on the leaves, and if they are constantly supplied with fresh ones, they grow very quickly. The outer covering of the skin, which is tough and does not grow, soon becomes too tight for them. So it splits open, leaving a new covering or cuticle underneath, which soon hardens when it is exposed to the air.

The caterpillar eats and grows, and eats and grows, until it has changed clothes three or four times, and then it is at the stage when it is known as the "silk-worm." It is time now for it to rest for a few days while it is going through the great change from a creeping caterpillar to a winged

moth. In preparation for this rest, it begins to spin a cocoon to cover itself. Two tiny drops of a

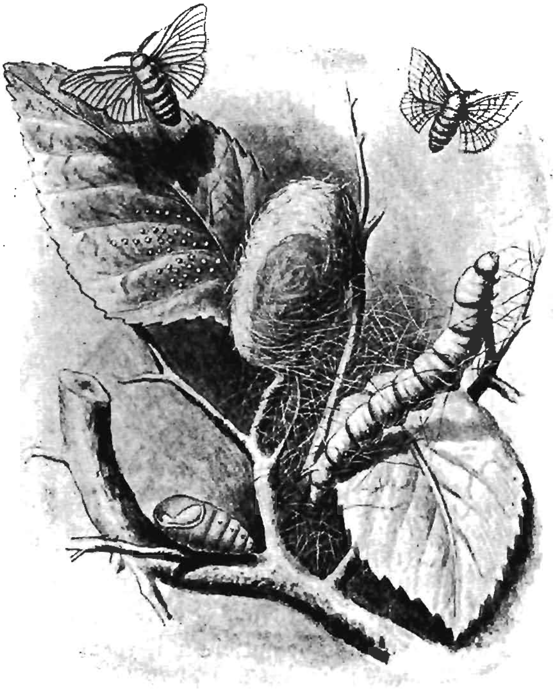


FIG. 39.—The Silk-Worm, the Cocoon, and the Silk-Moth.

sticky fluid ooze out from little holes in its lower lip. The fluid hardens at once in the air, and the silk-worm, by moving its head backwards and forwards in a peculiar way, forms it into a double

thread, which it then spins into an oval cocoon that surrounds its whole body.

Several days are spent within this cocoon, and then the full-grown silk-moth breaks out at the upper end.

But this spoils the silk for man's purposes, so only enough insects to supply eggs for another generation are allowed to break out. The others are watched until they are just ready to emerge, and the cocoons are then carefully unwound. The thread thus obtained is the raw material from which silk is made.

In many districts of Southern Europe, especially in France, the keeping of silk-worms has long been one of the most important home-industries among the peasantry. Every family used to keep silk-worms and sell the silk to the manufacturers. The best room in the house was set apart to their use; they were tended with great care, the women rising during the night to give them fresh leaves, or to see that the room was warm enough and not too warm. We are told that long ago in China (the original home of silk-worms), the silk-worm attendant was instructed to go into the rooms clad only in a single fold of linen, and if he felt too cold to make up the fire, if too hot to open the window. Nowadays the heat can be tested more simply and more accurately by looking at a thermometer.

One French writer tells us, that among the

people of the silk-producing districts the common salutation is not, "How do you do?" but "How are your silk-worms doing?" Yet, notwithstanding the care and anxiety the silk-worms cost their owners, up till 1849 they had always yielded enough of silk to repay the labour bestowed on them. But in that year a great disaster befell. A great many of the silk-moths showed signs of disease. No stage of the insect's life was free from it. Sometimes the eggs did not hatch at all, sometimes the larvæ died when they were a few days old, and very few of them produced cocoons perfect enough to be worth the trouble of winding.

It was thought at first that the eggs were at fault, and fresh ones were brought from the neighbouring countries. For one season this cured the trouble. The imported eggs hatched out perfectly, the larvæ developed, and when full-grown, spun perfect cocoons. The moths emerged safely enough and laid their eggs, but it was found that these eggs were just as badly diseased as the local eggs, and it seemed as if it would be necessary to import fresh eggs each season. For a time this was done, and the silk supply was kept up. But soon the trouble spread to neighbouring countries too, until, it is said, Japan was the only silk-producing country free from the disease.

The silk-rearers were in despair. All sorts of

remedies had been tried, but with so little success that thousands of families, who had depended on their silk-harvest, were reduced to want. The Government offered large prizes for a remedy, and at last

FIG. 40.—Louis Pasteur.

appointed a Commission to inquire into the whole subject. The head of this Commission was a distinguished chemist, who had had among his pupils one in whose ability he had great belief. This pupil was Louis Pasteur, whose discoveries were at that time just beginning to attract great attention.

When Pasteur was asked to undertake the work of investigating the silk-worms he refused at first. He was a chemist, not a naturalist, he said; he was interested in the work he was doing, and he had never touched a silk-worm in his life. But when he realised the enormous practical importance of the matter, and found that many thousands of his countrymen had been brought to misery by the failure of the silk-industry, he agreed to do what he could, and set off at once to Alais, a town in the midst of the silk-producing districts.

Some time earlier it had been observed that very small grains or "corpuscles" could be seen in the bodies of the insects the eggs of which did not develop. Pasteur, whose earlier studies had given him a clue to what these might be, examined them carefully under the microscope, and succeeded in watching them throughout the different stages of the insect's life.

He soon found out that these minute grains were in reality living creatures of a very simple kind, that they were handed on from the parent moths to the eggs, but that the eggs of healthy insects were never infected. The larvæ produced from these, however, often showed the disease, and the next step was to examine the food-leaves, the dust of the room, and everything about the insects to find out how the infection was spread.

After weeks of careful study and constant experiment Pasteur understood the disease so thoroughly that, we are told, he could cause it to appear in any given healthy insect on a given day.

This, of course, was the first step towards knowing how to prevent it. The first necessity was to avoid overcrowding, uncleanliness, overheating, and unhealthy conditions generally, since these gave rise to digestive disorders, which weakened the insects, and made them more liable to the serious disease. The next was to choose the most vigorous moths for laying eggs, and after the eggs were laid, to examine under the microscope the dead bodies of the parent insects. If they had no signs of the disease, the eggs were kept carefully apart from all possible sources of infection; but if the moths were infected, the eggs were at once destroyed.

This method was entirely successful, but it was not at once generally followed. Pasteur's theory, that the disease was due to the presence of a microscopic parasite living within the bodies of the insects, gave rise to so much violent dispute, that the Government were unwilling to accept his results.

So Pasteur was asked to repeat his experiments on a larger scale. A villa in Illyria, was placed at his disposal, that his methods might be applied under his own eye. The silk from the cocoons

produced in one season by the caterpillars reared on that estate alone, sold for over a thousand pounds. This was proof that could not be disputed, and Pasteur's methods were adopted everywhere. Every factory has its rooms in which the insects intended for egg-laying are carefully watched by women and girls. Each insect has strips of linen laid down for it, and the eggs are dropped on these. As the silk-moth does not fly at all, but simply walks about on the trays, it is easy to see to which the eggs belong. The moth, which dies soon after laying, as so many insects do, is pinned to the strips of cloth, until its body can be examined, and the eggs are carefully tended, or are destroyed according to the results of the examination.

Pasteur had hoped that by his methods the disease would soon be stamped out altogether, but this has not been the case. The silk-moth is apparently not the only insect which harbours the parasite, and so continual watch has to be kept over each generation. But with such care the disease has been kept within bounds, and the silk industry has been saved. It has been stated that France had lost at least £40,000,000 before Pasteur came to the rescue.

This silk-worm story is of interest, not only because it illustrates the way in which very different forms of life—man, silk-worm, and microbe—may

be linked one with another, but because it was the first application to disease of a discovery which has led to the most far-reaching results.

In the course of his earlier chemical investigations, Pasteur had discovered that sourness in milk, and some kinds of fermentation in beer and wine, were due to the action of very small living creatures, usually classed together as bacteria, which were visible only under a powerful microscope, and got into the liquid from without.

With this knowledge Pasteur set to work on the silk-worm problem, quite prepared to find, as he did find, that the disease was due to the presence of another minute microbe, which lived and multiplied within the bodies of the silk-worm.

After he had made sure that this was the case, and after he had recovered from a dangerous illness, brought on by too close devotion to his investigations, Pasteur went on to study other diseases affecting man's prosperity by the ravages they cause among his flocks. One of these, Splenic fever, not only carries off whole herds of cattle in a short time, but attacks man himself, if by any accident the poison from the infected animals gets into his blood. A German named Koch had already discovered the bacterium which gives rise to this deadly disease, and Pasteur was soon able to corroborate the discovery. Then he went on to

experiment with the bacterium, that he might find out a way in which its ravages might be made less terrible. He made the discovery almost accidentally, because he never neglected the smallest circumstance in regard to his experiments, that the bacterium could be "tamed," that is to say, could be so treated as to lose its deadly character. If this mildly poisonous bacterium were introduced into the blood of cattle and sheep, it gave rise to only slight symptoms of the disease, but it protected the animal thus treated from taking the deadly form of it, much in the same way as vaccination prevents small-pox, or, at any rate, robs it of a great part of its deadliness.

Pasteur went on to study many other diseases, and the best ways of treating them, and in every domain in which he worked "he left either a method or a clue." Other scientific workers, like Koch and our own Lord Lister, who has done so much to free surgical operations from their terrors, were working at similar problems affecting human welfare, and it is impossible to estimate how much has been gained from the study of the infinitely small microbes, not only as regards the treatment of wounds and diseases, but as regards the promotion of health and the improvement of food.

There has been much brilliant building on this foundation by later workers, and we may hope that

much more will yet be achieved. "We are as yet but on the threshold, and who shall say what triumphs shall await the labours of generations to come; but however great the achievements that may be theirs, in the future, as in the present, science must ever recognise the debt it owes to the genius of Pasteur."

CHAPTER IX

MOSQUITOES AND MALARIA

ANOTHER chapter in the history of modern medicine deserves to rank among the "fairy-tales of science"—the story of the discovery and prevention of malaria.

Malaria is a fever common in many parts of the world, in the low-lying parts of Southern Europe, and on the flats along the shores of the Baltic Sea, as well as throughout large tracts of Asia, Africa, and America. It is a very serious disease; thousands of people die of it every year, and thousands upon thousands suffer from it so much and so constantly, that they are rendered unfit for their ordinary duties. For the victim of malaria often recovers from one attack only to have another and another, at frequent intervals, often for years. Even leaving the climate

where the disease was contracted does not end the trouble, and the patient may go on suffering for months or years, until quinine, the only drug known to have any real effect on it, succeeds in ridding him of the disease.

So long as the causes of malaria were not understood, very little could be done to prevent it. Physicians and others worked ceaselessly to try to find out the causes, and in 1880 a French surgeon, who was examining the blood of a malaria patient under the microscope, discovered a small, very simple, single-celled animal, and thus "recognised for the first time the small organism, which has played a greater part in human affairs than the greatest politician or general that ever lived." Further search proved that these small parasites were always to be found in the blood of the victims of malaria, and it seemed certain that they were the cause of the disease. This was an important step; the next, obviously, was to find out how the parasites got into the blood.

It had long been suspected that there was some connection between the abundance of mosquitoes and the occurrence of malaria, since both were at their worst in the same regions and at the same seasons, but what the connection was had not been understood. Sir Patrick Manson, reasoning from the state of things discovered by him in another disease

happily unknown to us in this country, made the suggestion that the parasite might be conveyed into the human body by the *mosquito in the act of biting.*

Following *this suggestion,* Sir Ronald Ross made

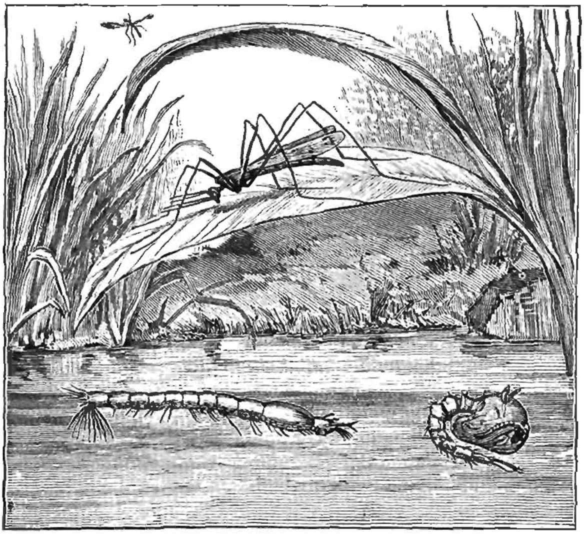


FIG. 41.—Mosquito. The full-grown insect is about $\frac{1}{3}$ inch long; the larva about $\frac{1}{2}$ inch.

a set of experiments in India by feeding all the different kinds of mosquito procurable on the blood of malaria patients, and then dissecting and examining every part of their bodies to see if there was any trace of the parasite. Hundreds of mosquitoes were thus laboriously examined, but for

two years there was no result. Still the tireless investigator persevered, and finally he found a species the blood of which showed certain characters in common with the blood of malaria patients. He was soon able to prove that all the mosquitoes of that particular kind fed on the blood of malaria patients became infected with the parasite which causes the fever.

The life-history of the parasite is difficult to follow, but it is sufficient for us to understand the general results gained so far: Malarial fever in man is due to a very minute parasite living in the blood. This parasite may go on living and multiplying in the blood of man for an indefinite time, unless it is killed by drugs, but it does not go through any further stage of its life-history, and cannot infect other human beings.

A mosquito biting an infected person receives some of the parasites into its own blood; there they go through a further stage of development, and, finally, the infected mosquito passes on the fully developed parasites to the next persons it bites, and these soon show symptoms of malarial fever.

But the last part of this story had still to be proved, and that no doubt might remain, an enthusiastic student of science, who had not been in a malarious country since his childhood, de-

liberately allowed himself to be bitten by infected mosquitoes brought to London from Rome. He took malaria, and the case was proved.

Another self-sacrificing experiment was necessary to prove that the bite of mosquitoes is the only source from which human beings are infected with malaria. Two doctors, with other two companions, offered to live in a hut in the very midst of a region "where scarcely a person spends a night without contracting malaria of a virulent type." They were to take no quinine or drugs of any kind, but the hut was to be made mosquito-proof, and they were not to leave it from one hour before sunset till one hour after sunrise, for mosquitoes are active only at night.

They lived thus for four months, and none of them ever showed a sign of malaria. It was a memorable day for science when a committee of Italian scientific workers visited them in their hut and telegraphed to England a triumphant "All Well."

Thus it was proved that malaria in man is due to a parasite communicated to the blood by the bite of the mosquito, *and in no other way.* The naturalist joined hands with the physician, and the habits and life-history of the mosquito were carefully studied.

The mosquito lays its eggs in stagnant pools

and marshy places, and the larva goes through all the stages of its life in the water, until, at the final moult, it emerges a winged insect.

We can watch a very similar life-history for ourselves if we search in spring and early summer for the little raft-like float of eggs of the common gnat in ponds, ditches, or rain-water barrels. The gnat is a very near relative of the mosquito, and the different stages of its life are very much the same.

If we put a clump of gnat's eggs in a glass globe of fresh water, in the bottom of which we have planted a few green water-weeds, we shall see the larvæ emerge in a few days. Failing the eggs, we may begin with the larvæ, which are very much easier to find.

The larvæ are blackish, active little creatures, from $\frac{1}{4}$ to $\frac{1}{2}$ an inch in length. On their mouth-parts there is a fringe of bristles which keep moving continually, and make a little whirlpool which sweeps food-particles towards the mouth. When at rest, the larvæ have a quaint habit of hanging head downwards from the surface of the water. They do this to take in air through a breathing tube placed near the end of the body.

After a few days the first moult takes place. The cuticle or outer covering of the skin, which does not grow as the body does, splits open along

the back, and the larva creeps out of it, leaving a perfect cast of itself behind. This happens three

FIG. 42.—Life-history of the Gnat.
Egg-raft, larva, pupa, and perfect insect.

times in about three weeks, the larva getting bigger each time. At the last moult the pupa stage begins. The pupa is much lighter in colour than

the larva, and has a large head, with a pair of breathing tubes projecting beyond it. The pupa does not feed—indeed it cannot, for it has no mouth—it simply waits till the wonderful change going on within it is complete.

Then it rises to the surface of the water; the cuticle splits up the back, and a perfect insect, with slender body, long legs, and gauzy wings, emerges slowly from the husk, and poises a moment to gain strength and hardness from the air. If the gnat is a male, the few days of its life are spent in joyous dances in the sunlight with its fellows, and in sipping nectar from the flowers. But the female wastes little time on the dance; she has sterner duties to perform, and in preparation for them she is equipped with strong biting jaws which the male lacks. She sets off at once on her quest of blood of man or beast, and pursues it ceaselessly, day and night, until her store of eggs is mature. Then she seeks out a stagnant pool like the one from which she came, and there she deposits her eggs, mooring them fast with some sticky substance to the leaf of a water plant. Her work done, and the future of her race secured, she usually dies almost at once of sheer fatigue.

The winged mosquito may be borne for a considerable distance by the wind, but it cannot fly far, and is usually found within a few hundred

yards of the breeding-place. As with the gnats, it is the female alone that sucks blood; the males keep to a daintier diet. The insects are active only at night.

This knowledge of the habits of the mosquito pointed out many means which might be used to prevent malaria. We have already seen that individuals can escape it by keeping mosquitoes out of their houses, and by not going out at night. Since it has been thoroughly understood that the irritation from the bite of a mosquito is only a very small part of the trouble it may cause, travellers have been careful, when passing through an infected district, to use their mosquito nets when sleeping, and to pitch their camps so that the wind does not blow from native villages towards them.

But more has been done than this. It was found that when the surface of the stagnant water was coated over with a thin film of paraffin oil, thousands of the developing larvæ died—especially at the change to the pupa state, when they come up to the surface. This method has been tried on many pools in the neighbourhood of human dwellings. Where the water is used for drinking, paraffin cannot be added, but it was found that trout devour enormous numbers of the larvæ, and these have been introduced into ponds suitable for them. In

this way some districts have been almost entirely freed from malaria.

England, as we have seen, got rid of ague, which is really malarial fever, when the country was drained of its swamps. We have mosquitoes in many parts of the country still, but, as the malaria microbes have died out, the insect's bite, though irritating, does not cause disease.

The mosquito is unfortunately not the only insect the bite of which may carry disease and death. In many parts of Africa there are regions which it is quite impossible to colonise, because no domesticated animals can be kept alive in them. It is a great risk even to cross these regions, and travellers have to choose their times for passing through them carefully, lest they lose all their horses and draught oxen.

This is due to the presence of an insect, the tsetse fly, and the regions it infests are known as "fly-belts." The tsetse lives by biting the larger animals and sucking their blood. Like the mosquito, it is often the host of a particular living organism, which passes into the blood of the animal bitten, develops and multiplies there, and gives rise to acute feverish symptoms, usually ending in the death of the victim.

This parasite is said to live in the blood of the larger wild animals, including the crocodile, but the

wild creatures have adapted themselves to it and do not suffer from the disease. But they do pass on the parasite to the flies which bite them, and when the infected insects next bite domesticated animals which are new to the country, these quickly develop the disease in its most virulent form. For a time it was thought that wild buffaloes were the only source of infection, and it was proposed to exterminate the buffalo; but more thorough investigation in different parts of the country showed that this was unnecessary, for there were fly-belts where there were no buffaloes.

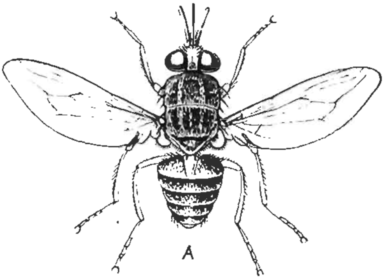


FIG. 43.—Tsetse Fly.
(About three times natural size.)

It is also a tsetse fly that is the link between the parasite and its human victims in that deadly disease known as sleeping sickness, which seems to follow in the footsteps of civilisation in Africa at the present day. So far not much is known as to the history of this parasite or the means for combating it, but a great deal of careful scientific study is now being devoted to it, and we have every reason to hope that in this case, too, science will gain the victory.

CHAPTER X

INTER-RELATIONS AMONG ANIMALS

LEAVING human beings as far as possible out of the question, let us now consider for a while some of the ways in which the lives of animals are inter-linked one with another, and with plant life.

The chief needs of animals are the same as those of man—sufficient food and safety from enemies, so that they may bring up their young. For the necessary food they, like man, are entirely dependent upon other animals and on plants.

Just as we found that many races of human beings live directly by hunting, so we find that many animals are also hunters, going forth daily or nightly to kill, sometimes by strength alone, more often by strength combined with cunning.

We have already referred to the greatest hunters among animals, the Cat-like animals—lion, tiger, leopard, jaguar, puma, and many smaller kinds, which hunt alone or in pairs and family parties; and to the Dog-like animals—wolf, jackal, wild-dog, dingo, and fox, most of which join together in large packs under the command of a leader chosen for his strength and experience.

But these are not all. Many of the smaller mammals are hunters too. Most dreaded by all the

FIG. 44.—Weasel. Body, 8½ inches long; tail, 2½ inches.

smaller wild things in the woods are the weasel and his relatives the stoat and the polecat. For the weasel pursues the prey once seen or smelt, silently and relentlessly, never giving up, never

FIG. 45.—Stoat. Body, 10½ inches long; tail, 6½ inches.

failing to find it. It follows the rabbit into its burrow, kills the young hares in the form or bed and crouches down among their dead bodies till the mother comes home; bites through the neck of the

brooding bird on its nest, and chases the terrified squirrel from branch to branch. It tastes only the blood or brain of its victim, and kills many animals in a night, apparently for sheer love of killing.

Among birds there are many notable hunters,

FIG. 46.—White-tailed Eagle.

even in our own country. The golden eagle, though no longer common in Britain, still occurs in many parts of Scotland and in the west of Ireland. It is, we are told, "one of the boldest and most enterprising of all the larger birds of prey, killing and devouring such creatures as grouse, ptarmigan, mountain-hares, lambs, kids, and fawns."

The eagle builds its nest, or eyrie as it is called,

high up on a steep and often inaccessible cliff, generally in a hollow or under an overhanging ledge, which shelters and conceals the young ones. There are usually two young ones, but often there is only one. So long as the eaglets are very small the mother feeds them with carefully prepared soft food, but as their beaks and claws grow stronger they need more solid fare. Then both parent-birds make long hunting expeditions daily, throughout their whole domain—for each pair ranges over a district many miles in extent, and tolerates no intruders within it. The prey caught is brought to the eyrie, and laid down beside the young ones, that they may tear it to pieces for themselves, and so take the first step towards learning their business in life.

When game is scarce some of the larger eagles do not disdain to turn robber, and force the smaller birds of prey to give up to them what they have caught. One naturalist gives us a vivid account of an incident of this kind which he was fortunate enough to see.

An osprey, one of the smaller eagles, which lives mainly upon fish hooked out of the water with its claws, was watched by an eagle from a cliff as it swooped down over the water. "For a moment it is almost hidden in the foam and swirl; the next, it emerges out of it, and mounts with powerful

beats into the air, its head stretched shorewards and its bent claws struck deep into the body of a large fish, beneath the weight of which it labours. Slowly at first, but gaining strength and speed as it ascends, it heads towards the cliffs' face. Already it can see the crag on which its eyrie hangs, when, like a thunderbolt, and with the shriek or laugh of a demon, the lonely watcher, who has marked it all, hurls itself downwards on spoiler and spoil. With a quick turn the startled bird avoids the furious rush, but almost at the same moment another maniac laugh, answering the first, drowns its own note of anger and despair, as the mate of the eagle that has commenced the attack swoops down towards it from a neighbouring pinnacle. All striving now on the osprey's part is in vain. Like storm-clouds the two strong robbers gather above him, and descend like the jagged lightning out of them. Their screams sound almost in his ears, their claws have cut his feathers, when his own reluctantly relax their grip, and the glittering booty falls. There is a rushing wind of wings, an overshadowing darkness in the air, the trail of light is checked in its descent, and out of that whirlwind of excessive speed an eagle soars serenely to the sky, bearing a fish in its claws."

It is only occasionally that an eagle condescends to robbery of this kind. But there are other birds,

the skuas, or robber gulls, which make a constant practice of forcing the weaker gulls to give up the fish they have caught. We may sometimes see even one of the commoner gulls chasing a little gull or a kittiwake through the air, flying round it

FIG. 47.—The Butcher-bird (Great Shrike).

and teasing it until it yields up the fish it has not only caught but swallowed.

Many other of our birds, such as the buzzards, kites, hawks, falcons, and owls, are birds of prey, and these, though they take occasional toll of game birds and even poultry, destroy enormous numbers of the too abundant field-mice, and so help to preserve the balance of nature.

Among the smaller birds there is one—the

shrike—which, not content with diligently searching for insects and grubs like its useful relatives, the thrushes, has adopted the habits of a bird of prey. It kills smaller birds, as well as big beetles and humble-bees, and it has the curious habit of making a "larder" in which it hangs up its victims by sticking them on thorns. This habit has gained for it the unpleasant name of "Butcher-bird."

In the sea, where plant-life is less abundant and less widespread, there is *much hunting of a kind*. The big fish eat the smaller ones, the smaller ones those smaller still, and the eggs of all are devoured in thousands. But the sea is wide, and her children are numerous. A single oyster is said to give rise to sixteen million young ones, and of these on an average not more than two may live to grow up and give rise to a new generation. Yet there are always oysters.

Even the full-grown oysters, that look so safe within their limy shells, have many enemies in addition to man. The sea-snail with its curious toothed ribbon bores its way through the shell. The sluggish starfish clambers upon the shell, surrounds it with its arms, clasps itself firmly to it with its many little sucker-feet, and then pours forth a fluid which paralyses the oyster. Its muscles relax, the shell gapes open, and the starfish has very soon gained possession of the delicacy within.

Spiders are perhaps among the most interesting of the smaller hunting animals. They are specially fitted for their task by their power of spinning. Let us think for a while of the common British garden spider and the web it makes.

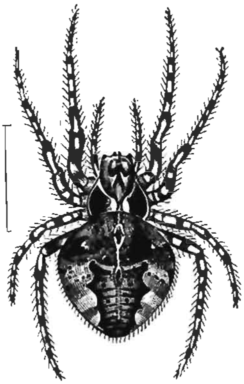


FIG. 48.—A near relative of the Garden Spider. About four times natural size.

The spider is a "jointed-footed" animal, only distantly related to insects. The head has simple eyes, a pair of poisonous jaws with which the prey is bitten to death, and a pair of palps or feelers. There are four pairs of walking legs, instead of three pairs as in insects, and each leg ends in tiny claws. On the posterior part of the body there are three pairs of little knobs pierced with fine holes like the "rose" of a watering-can. These are the spinnerets. Hundreds of little tubes lead from these to minute glands from which liquid silk flows out. This liquid passes out through the little tubes to the openings of the spinning organs at the will of the spider, for it requires a muscular contraction to squirt out the fluid. It comes out as a fine spray, but the jets fuse together, and the silk hardens at once into a fine thread. All the

spinnerets may be in use at once, or only some of them, so that the thread can be varied in thickness according to the use to which it is to be put.

To make the web the spider first gives out a long thread, makes it fast at one end, and lets it sway in the wind until the other end catches. Having thus made a bridge across the space the web is to occupy, the spider is able to walk along it, and spin the rest of the web at leisure. After the sides of the space are enclosed with lines, the spider lets itself down by a thread to a central point, where it spins a little more silk and then drops to the lowest foundation line, pulling *the first ray* taut behind it. Climbing up again to the central point, it pays out another ray and pulls it *taut to an upper corner. So ray after ray is formed,* all meeting in the centre like the spokes of a wheel.

The rays finished and strengthened, a spiral thread is next made from the centre to the circumference. But this is only a temporary rough scaffolding. The spider works back along this to the centre again, laying another and stickier thread, and biting off and rolling up the first as it goes. Then the little ball at the centre is bitten out, and a line is spun from the centre to a hiding-place near, where the spider patiently awaits its victims.

The line acts as a sort of telegraph, for when a fly strikes against the web, the line trembles and

the spider immediately lets go, so that the web becomes loose and the fly is hopelessly entangled. Then the spider rushes down on its prey, cuts it out of the web, spins silk threads round it to prevent its escape, and carries it off to the nest. After biting it to death with its poisonous jaws, it slowly sucks the juices from the body of the fly, until nothing is left but a husk. The spider then mends up the web again, and patiently waits for another victim.

There are many other kinds of spiders which make different kinds of webs. Some live in tunnels which they line with silk; others in a mere tube of silk of their own spinning. Specially remarkable are the trap-door spiders which make a nest in the ground, and fit it with a trap-door which swings shut behind the spider, and can be held firmly down from the inside. The trap-door has a silken hinge, and is covered over with particles of earth on the outside, so that it is quite like the ground, and often very difficult to find.

The large spiders, known as tarantulas, whose bite is greatly dreaded even by human beings in the warm countries in which they live, do not spin a snare at all. They live in open burrows and trust to their strength and quickness, and their powerful poison-jaws, to provide them with abundant food.

Another large hairy spider, found in Brazil and

some other countries of South America, makes a web so strong that even small birds flying against it are entangled so firmly that they cannot break loose. The spider enmeshes the birds and sucks the juices from their bodies, just as our common

FIG. 49.—Tarantula Spider. About natural size.

spider sucks a fly. This formidable creature has a body more than two inches long, and its legs have as large a spread as a man's hand. It is known as the Mygale or "bird-catching spider."

A traveller quite recently found that in some parts of the world man has turned the spider's fly-

catching habits to account for his own comfort. The spider in question is extremely sociable in its habits, and hundreds of them spin their snares close together, so that a tree may be covered with their

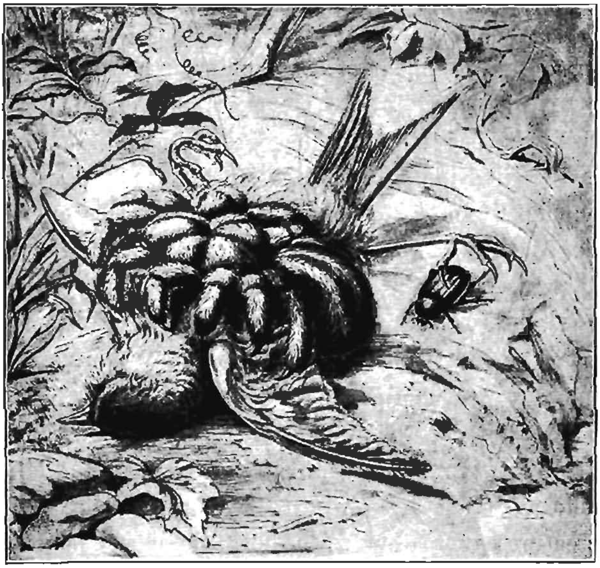


FIG. 50.—Mygale (Bird-catching Spider).

webs. The inhabitants of the country break off a branch of the tree, and take it into their houses to rid them of flies.

A very interesting point in connection with this story is, that a little beetle is always found living among these spiders. The beetles feed on the hard

parts of the insects which the spider has sucked, just as the jackal feeds on the scraps left by the lion. Were it not for these scavengers, the presence of the branch of webs filled with the decaying remains of insects might be unpleasant, but the beetles keep it sweet and clean, and so the dwellers in the house profit by the labour of both spider and beetle.

Notwithstanding its cleverness as a hunter, the spider is very frequently itself the hunted. Its body is soft and juicy, its poison-jaws are not powerful enough to be of much avail against a larger enemy. So, as Dr. McCook, a great American authority on spiders, has said, "its natural end is a violent one." "To feed the hungry maw of a stronger, more skilful, or more fortunate fellow-spinner; to be paralysed and entombed within a clay sarcophagus by a mother wasp, and serve as food for a growing waspling worm; to be snapped up as a delicate titbit by birds, toads, and all the other creatures that prey upon her; these are some of the modes by which, in the appointment of nature, the spider meets that doom which must befall all living."

The robber-wasps, in particular, make great havoc among spiders. These wasps have the habit of catching living prey and stinging it, so that it is paralysed but not killed. Then the wasp drags her victim to a little hole she has made, lays an egg

beside it, and closes up the hole. When the grub emerges from the egg it immediately begins to feed on the still living but, let us hope, unconscious spider. One wasp even entices the spider out of its own hole, stings it and drags it in again, laying her egg beside it and closing up the entrance.

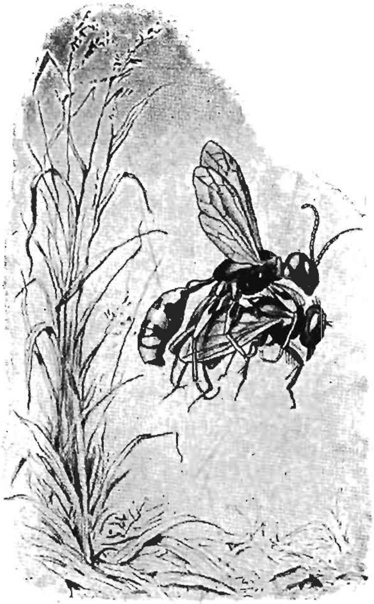


FIG. 51.—Robber-Wasp carrying a Fly.

The ichneumon fly provides for her young by laying her eggs actually in the body of some other insect or of a spider, and the young, when hatched, feed on their living host. They only quit it at the end of their larval life, and by that time the victim is usually dying, if not dead.

After the larvæ, now full-grown, have left their host, they have to forage for themselves, and thus they are saved from the doom of degeneration

which, in the long run, overtakes all living creatures, animal, plant, or human, if they depend entirely upon others, without making any exertion on their own part, or giving any benefit in return.

Among many classes of animals there are some which spend their whole lives upon or, like many worms, inside the body of other animals. In many of these cases, those which live in this way are less highly developed than their near relatives who are living a free life and fending for themselves.

One case will help to make this clear. It is a particularly instructive one, for the animal in question, a young crustacean called *Sacculina*, starts life in the usual way, and has a free-swimming stage, provided with three pairs of limbs, a food-canal, an eye, and much else just like many other young crustaceans.

But after a time it gives up its free-swimming life and attaches itself by its feelers to the back or limbs of a young crab. It loses more than half its body, and as a little sac, or pouch, it sinks into the interior of its host. Eventually it protrudes like a bean on the under side of the crab's tail, and absorbs nourishment through little tubes from the crab's body.

It has little power left except that of laying eggs. For Nature always takes care of the race;

but the individual must take part in the struggle for existence, or must sink gradually down to a lower level of life.

> Contention is the vital force,
> Whence pluck they brains, her prize of gifts.

CHAPTER XI

AIDS IN THE STRUGGLE FOR EXISTENCE

THE life of animals is one of continual struggle. They have to put forth constant efforts to find sufficient food, and they have to be unceasingly on the alert to protect themselves from being eaten up by others. They have also very often to adjust themselves to changes of climate and in their surroundings. But Nature has worked out many devices to aid her children in this struggle.

In our chapter on domesticated animals we saw that man is able, by selecting carefully those which are to be the parents of the next generation, to change a race of animals so that it becomes more and more suited to the work he requires of it.

Nature, too, is continually changing animals, but she does this much more slowly—so slowly that a human life is far too short to see much of the process. We can see in some case what changes

have taken place by comparing the animals of the present with their relatives in the past, some of whom have left their history written more or less clearly on the rocks. We can sometimes guess at the changes, too, by watching the growth and development of young animals, for the young often pass through in their own lifetime some of the stages in the history of their race. Most clearly of all, we can understand them by comparing nearly related forms, in which the same organ is seen at different stages of evolution.

But how does Nature choose out the parents of each generation, and so ensure that each race of animals shall be kept up to a high level of efficiency? She does so, in part at least, by means of the continual struggle for existence.

A great many animals are born, but few of them grow to maturity and bring forth young ones. It is on the whole the strongest, the cleverest, the most alert animals, those best equipped in some way or other for the particular circumstances of their life, that are most successful in obtaining food, and in avoiding dangers, and that therefore live longest and hand on their good qualities to the largest number of young ones. It is they, too, who will be able to feed their young ones best, so that in every way these will get a favourable start in life.

This does not always hold good, for chance plays a large part. Even the strongest and the most wary may fall victims to enemies of another race, and a sudden change of climate or surroundings may sweep off good and bad alike. But on an average it is true that the "fittest" survive, and as Nature has been working through long periods of time and with enormous numbers, each race has become more and more "fit," that is, better and better suited to the kind of life it has to live.

We must, however, take care not to think of struggle as only or always meaning fighting, and of the lives of wild animals as being full of fear and suffering. Struggle often means effort, or endeavour, and the putting forth of this effort is more likely to be pleasant than painful. "When they reach maturity," writes Dr. Russel Wallace, "their lives are a continual round of healthy excitement and exercise, alternating with complete repose. The daily search for the daily food employs all their faculties and exercises every organ in their bodies, while this exercise leads to the satisfaction of their physical needs. In our own case, we can give no more perfect definition of this exercise and this happiness, and we must therefore conclude that animals, as a rule, enjoy all the happiness of which they are capable."

Even the animals that most frequently fall victims

to beasts and birds of prey do not think about their danger, and so are not afraid till it is actually present. Death, when it comes, comes swiftly and suddenly, and therefore in most cases painlessly.

We cannot doubt, when we watch the timid rabbits at play in the fields on summer evenings, that they enjoy life, notwithstanding its many dangers. And if we watch a couple of parent birds toiling for many hours of every day to bring food to their hungry young ones, we cannot but be impressed rather with the joyousness of their life than with its hardship.

Yet we must admit that there is a great deal of warfare in nature. To realise this we have only to think of the many weapons with which animals are furnished: the terrible teeth and claws of the carnivores, the hooked beak and talons of the birds of prey, the poison fangs of the snakes, the jaws of the spiders, the stings of many insects, and a thousand more.

But if there are many weapons of offence, there is also much defensive armour, for Nature is an impartial mother to all her children. The armadillo is sheathed in hard bony plates; the porcupine bristles with sharp quills; our own hedgehog rolls itself up into a prickly ball which no dog or fox can touch without discomfort.

The skunk flaunts its conspicuous black and

white colouring openly and fearlessly in broad daylight, secure in its power of suddenly throwing out a fluid of such horrible nastiness that neither man nor beast will willingly come within reach of it. The skunk is the only mammal provided with this power of ejecting an offensive fluid secreted by a special gland, but some others, like the llama, have the trick of spitting a large quantity of saliva at any one who annoys them. Many other animals, such as the toad, are rarely eaten by others, because of their sharp and bitter taste.

The crabs and lobsters, whose powerful pincers are a terror to other animals, are themselves well protected by their hard covering. Their armour has not the power of growth, and when it begins to get too tight it splits open, and they creep forth from it, soft and defenceless. For some days they have to keep in hiding as much as possible, but many of them must be snapped up before the new coat of mail has hardened.

The hermit-crab has no hard armour on the hind part of its body, and would form a tempting morsel for many a hungry maw, if it had not learnt to tuck its defenceless tail safely into the empty shell of a whelk or periwinkle. It carries this borrowed house about with it wherever it goes, and retires within it at every threatening of danger, just as a snail retreats into its own shell.

Another of the ways in which both hunters and hunted alike are helped in the struggle for existence is by resembling in colour the general colouring of their surroundings. They are thus very inconspicuous, and so escape many dangers.

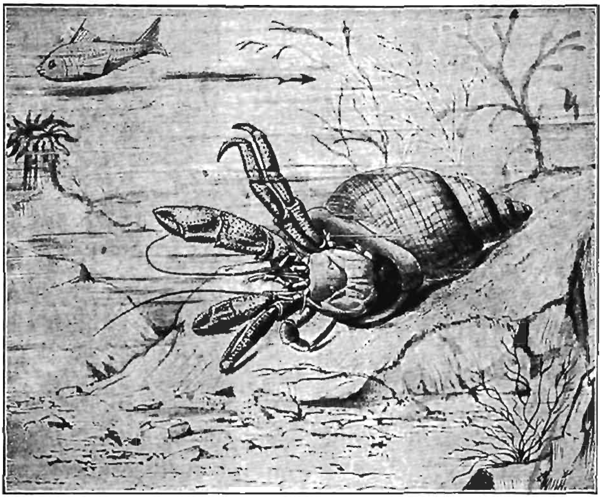


FIG. 52.—Hermit Crab.

Many animals living in the Arctic regions among perpetual snow are white. The Polar bear is white, or rather whitish in colour, though his relatives elsewhere are nearly all brown or black.

A little farther south, where winter does not hold sway the whole year round, the colouring of the animals changes with the season. The Arctic

fox, the ermine, the mountain hare, and the ptarmigan are all grey, brown, or mottled during summer, but change into a white dress on the approach of winter. A few others in the same region keep their summer colouring the whole year through, but these are usually fairly well protected in some other way. The sable, for instance, gets its living among the bare branches of the trees, where white would be much more striking than its own rich brown fur.

Animals living in the desert are usually of a tawny or sand colour, not uniform but of different shades, so that at a little distance they can hardly be detected. The traveller Brehm writes of the sand-grouse, a bird about the size of a pigeon, that it feeds or suns itself at ease, careless of the approach of man. "What sportsman would their presence not excite? Sure of his booty the inexperienced traveller shuts up his field-glass, gets hold of his gun, and slowly approaches the gay company. But the birds disappear before his eyes. None has run or flown, yet none is to be seen. It seems as if the earth had swallowed them. The fact is that, trusting to the likeness between their plumage and the ground, they have simply squatted. In a moment they have become stones and little heaps of sand." . . . "The sand-coloured upper surface, sometimes shading into grey, sometimes towards bright yellow, is broken and adorned by

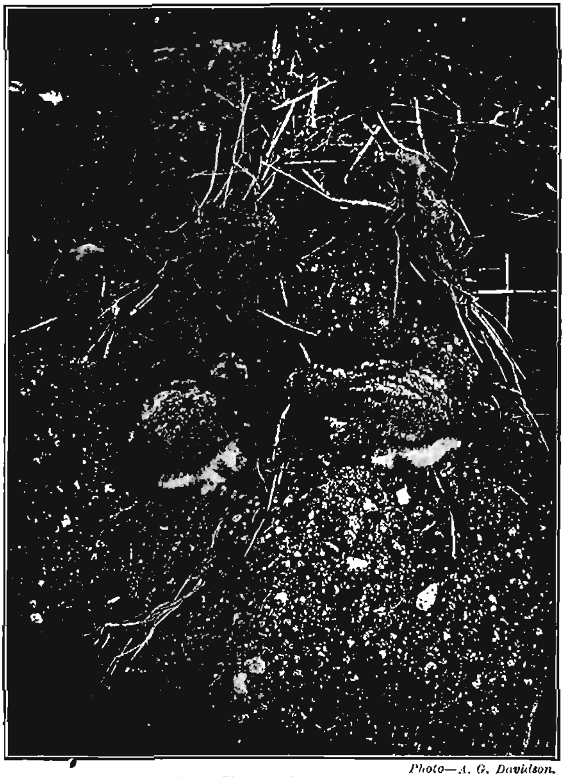
broad bands, narrower bars, delicate lines; by dots, spots, points, streaks, and blurs; so that one might fancy that birds so marked must be conspicuous

Photo—Chas. Reid.

FIG. 53.—Lapwing and Nest.

from a distance. But all this colouring medley is simply the most precise copy of the ground; every dark and light spot, every little stone, every grain of sand seems to have its counterpart in the plumage.

It is no wonder, then, that the earth can, as it were, make the bird part of itself, and so secure its safety."



Photo—A. G. Davidson.

FIG. 54.—Young Oyster-Catchers.

But we need not go so far afield to find birds that exactly resemble their surroundings. The young woodcock on the brown pine-needle carpet of

our own woods in spring, the young lapwings on the ploughed fields, and the tiny oyster-catchers on the shingle by the river all harmonise perfectly with the colour of the ground, and when they "squat" and keep absolutely still, as they do when any danger approaches, it is almost possible to step on them without seeing them.

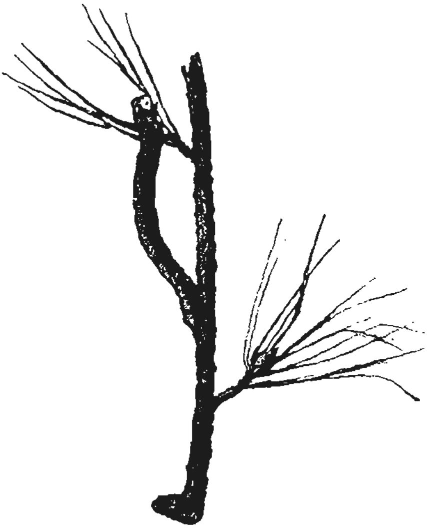


FIG. 55.—The Larva of Peppered Moth reared amid dark-brown twigs and leaves.

Among insects there are many very remarkable cases of "protective colouring." Many caterpillars closely resemble the plants on which they feed, and it has been shown by experiment that caterpillars of the same species may take on quite different colours if they are brought up on differently-coloured plants.

Very strange, too, are the cases in which insects resemble a dead natural object—a withered leaf, a shred of moss.

One butterfly, which is brightly coloured on the upper surface of its wings and very conspicuous when flying, becomes almost invisible when it settles on the bark of a tree and erects its wings over its back in the resting attitude, for the lower surface of the wings is coloured exactly like a withered leaf.

An experienced naturalist, who has studied butterflies and moths with great care, tells us that he once picked up what he at first thought was a moth, examined it, and threw it down disappointed, as it was only a little piece of wood. Then it opened its wings and flew away!

Among butterflies, too, we find many cases of *mimicry*. Some butterflies are not eaten by their chief enemies, the birds, because they have an unpleasant taste. These butterflies have no need of protective colouring and are usually conspicuous. Indeed, the more conspicuous they are, the safer it is for them, since the birds who have to find out by experience that they are not good to eat will learn all the more quickly to recognise them.

In the regions where unpalatable butterflies occur, there is often another kind, sometimes several others, almost exactly like them in colouring, though they are not nearly related to them at all. The butterflies which *mimic* the protected kind are themselves quite good to eat, but they are left alone by the birds, which do not readily distinguish

between them and those they have learnt to avoid because of their nasty taste.

All the "adaptations" that we have been considering, and they are only a few out of the

FIG. 56.—Imitation of a Flower by a young Mantis (*Hymenopus bicornis*); after Wallace.

many that are known, are aids in the struggle between one species and another. But the competition for food between individuals of the same species may be very severe.

If we look, for instance, at a gooseberry bush infested with the caterpillar of the magpie moth

which eats the leaves, we see that the caterpillars are crowded closely together on a branch. They strip it bare of every leaf, then coil themselves into a ball at the end of it and drop to the ground, to climb another branch and begin again. It is obvious that where they are so crowded, the strongest and most active will get most leaves, and a great number will get so little food that they will never develop into moths at all.

Nature has found various ways of lessening this kind of competition too. One of these is that animals very similar to each other have, at some stage in the history of their race, taken to different kinds of food, and thus a much larger number can live on the same area than if they were all dependent on the same plant or animal.

Thus, as Dr. Wallace has pointed out, we have several species of titmouse in this country, which do not compete with each other. The great tit is large and has a strong bill, and it feeds on the larger insects, the smaller coal-tit takes smaller insects and seeds, and the dainty little blue tomtit picks out grubs from the bark of trees. Another of the family lives in marshy districts, and yet another in the pine-forests. The same is true of many other birds, such as the pipits, which are all so nearly alike that it is probable that they are all descended from the same stock.

A very interesting case is that of the "dipper," or water-ouzel. The dipper is a pretty little dark bird with a white breast, that may be seen on almost any of our northern mountain streams. It gets its food — water-beetles, insect larvæ, and the like—entirely from the water. It has the remarkable power of flying under water, its plumage being so dense that its body never gets wet. It finds abundant food all the year round, as the water of a rapid mountain stream never freezes.

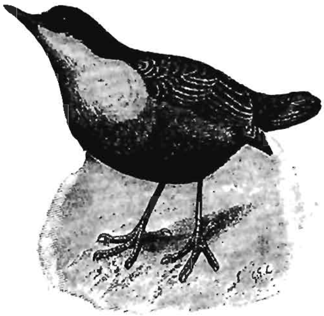


FIG. 57.—The Dipper.

"There then we have a bird which in its whole structure shows a close affinity to the smaller typical perching birds, but which has departed from all its allies in its habits and mode of life, and has secured for itself a place in nature where it has few competitors and few enemies!"

What a "golden age" it must have been for the dipper when it first discovered this "vacant place" in nature! It probably did so very gradually, beginning by feeding on the banks of streams and gradually adapting itself more and more to its new

way of life. For though all our thrushes and wrens, the nearest relatives of the dipper, live entirely on land, there are "water-thrushes in America which wade into streams and pick out minute animals from the bottom. Their plumage becomes drenched, but can be shaken dry in a moment. Certainly the water-thrushes have taken many preliminary steps towards becoming as aquatic as the dipper."

Among many animals the struggle is made easier in other ways. When the first touch of cold weather comes and food begins to get scarce a great many creatures grow sleepy. This sleepiness occurs in many degrees up to actual "hibernation," as laying up for the winter is called. Many animals that do not hibernate at all lose their activity and become heavy and quiet, and so need less food than when they are in full vigour.

Others, again, hibernate partially, waking up on any warm day to feed, and then going to sleep again. Most of these lay up stores for the winter. The squirrel is one of these lighter sleepers, and it wakes up at frequent intervals to nibble at its hoard of nuts. The wood-mouse remains hungry all the winter, though it sleeps a good deal. It is a terrible trial to the farmer, for it gathers and buries grain, peas, and beans "by the pint" for use in the cold weather. The tiny harvest-mouse, whose pretty little oval nest of woven grass blades may

sometimes be found swinging between two corn stalks, also hoards for winter needs, but it does not require nearly so much as its bigger cousin.

The heavier sleepers lay up no stores. They feed fast and hard towards the end of summer, and

Photo—Douglas English.

FIG. 58.—The Harvest-Mouse.

when the cold weather comes they are very fat. Then they retire to their various hiding-places. The bear scoops out a hole in the snow; the badger coils itself up in its burrow; the hedgehog buries itself in a nest of withered leaves; the bat hangs by its toes from the roof of some dark cavern; the frog

hides in the mud of the swamp, shuts its mouth and nostrils, and breathes only through its skin.

In all these heavy sleepers life is almost at a standstill. They breathe slowly, the heart beats slowly, there is little expenditure of energy, and the waste-products are allowed to accumulate. The hibernating animal is like a smouldering fire, almost choked in its own ashes, and giving off little heat and flame, but still keeping alive, and ready to burn up brightly again when air is admitted and fresh fuel supplied.

During this period the store of fat laid up in advance is gradually used up, and when spring comes the sleepers emerge from their retreats lean, hungry, and cross. It is at this time that bears are so greatly dreaded; they wake up long before the roots and fruits they love are abundant, and in their desperate hunger they will attack anything or any one.

Many of the birds have a way of their own of avoiding hard times and the keen competition they bring. As soon as food begins to get scarce, and long before cold weather has actually set in, they assemble in bands. Day by day new companies join them, they take preliminary flights in wide circles as if to try their strength and make sure of their way, and finally they fly away to southern lands, where the sun always

shines and food is always abundant. The young birds go first, the older ones later. They linger on the way, stopping to rest and feed very often, but before autumn is over all the migratory species have changed their abode.

Some birds remain with us all the year round, but though the same kinds are with us in winter which we are accustomed to see in summer, it is thought that many of them are different individuals which have come from colder districts farther north.

Many, such as the swallows, leave Britain altogether and fly to Africa, to return regularly to their northern home when spring comes round. For their winter quarters are a mere playground; the home of a bird is by the cradle of its young ones, and it is in the colder north that the bird lives its real life of love and labour.

CHAPTER XII

SOCIAL LIFE AMONG ANIMALS

THE life of animals, as we have seen, is not all warfare, and neither is it all competition. For many animals have found out, just as man has done, that union is strength, and that by banding themselves together for mutual help and protection,

even those among them which are *individually* weak are able to hold their own in the "struggle for existence."

We all know the old story of the merchant who

FIG. 59.—A Wasp's Nest.

taught his quarrelsome sons the value of combination by means of a bundle of slender rods tied together. One after another the sons tried to break the rods, but they could not succeed. The father then untied the bundle, and showed them how easy it was to break each separate rod. Many

animals seem to have learnt the same lesson by experience.

"Mutual aid," says one writer, "is as much a law of animal life as mutual struggle." And he goes on to say that this mutual aid has probably been more important than struggle in the history of animals, since it allows habits and powers to develop, which ensure the success of the "species," together with the greatest amount of welfare and enjoyment of the individual.

Let us consider a few examples of different stages of social life among animals.

Some animals seem to come together in an almost haphazard fashion, simply because they are all blindly following the same instinct at the same time. When food grows scarce many rodents, such as rats, gather together in enormous numbers, and migrate in company.

The lemmings on the Siberian tundras migrate in this way at the end of a season, when they have been more than usually abundant, and have exhausted the food available. They march northwards in closely pressed ranks, but it is not an organised march after a leader; they simply pour straight onwards like a living stream, turning aside for no obstacle.

If a mountain stands in their way, they go up one side and down the other, never attempting to

go round. If a river crosses their path, they plunge in and swim to the other side—those who can.

Many are carried away, many become exhausted and die on the march, many more are snapped up by the birds and beasts of prey that continually

FIG. 60.—Peregrine Falcon and Lemmings.

harass the rearguard of the lemmings. But those that are left plod steadily onwards, resting by day, and marching by night, eating every blade of grass and every growing plant as they go, just as the migrating young locusts do in southern lands.

Eventually, in many cases, they reach the shores of the sea, but even that does not stop them. They plunge boldly in, and the waves sweep over them.

The lemmings' march cannot be called intelligent combination, but we can find very good examples of this, even among the rodents or gnawing animals, the order to which the stupid lemmings belong.

The viscacha is very abundant on the pampas of South America. A number of these animals, usually from twenty to thirty, make their burrows with the entrances close together, and often opening into a common trench. All the earth is carried out to a little distance and thrown into a heap, which forms a little mound, often about two feet high, in front of the "village." There are generally several such villages within easy reach of each other. The inhabitants of each village sit on their own mound at dusk, and disappear into their burrows so quickly at a warning cry from one of them, that dogs almost never succeed in catching them. After sunset the viscachas go a-visiting. Those of one village go to see their neighbours in another, and sit on their mound chattering in friendly fashion. Narrow trodden paths from village to village show how constant this habit of exchanging visits must be.

One result of the friendly and sociable life of these little animals is that, though they do not stand very high in the scale of intelligence, they have a wonderfully varied "language." Their cries "are varied a thousand ways in strength and intonation, according to the age, sex, or emotions of the

individual." "I doubt," writes Mr. Hudson, the naturalist to whose beautiful books we owe so much of our knowledge of the life of the Pampas, "whether there is in the world any other four-footed thing so loquacious, or with a dialect so extensive."

So strong is the attachment of the viscachas to their kind, that if the burrows of one village be filled up—for this is the method by which the farmer tries to get rid of them if they are too destructive—those from other villages will come by night and dig them out again. They are probably excited by the cries of the little prisoners, and burrow their way down to them.

Still keeping to the rodents we may go on to describe a still higher type of social life. In this case the animals not only live beside each other in peace and friendliness; they unite together to do pieces of work which would be impossible for one, and benefit the whole colony. Some of these works are so extensive that they may entirely change the features of a landscape. The workers are the beavers.

Beavers are still found in considerable numbers on the banks of the streams in some of the western parts of North America and in Canada. They were quite abundant in Britain at one time, but had died out or been killed off by the fourteenth century. Within the last few years a colony of them has been

kept and carefully protected in Sussex, and there they carry on all their usual activities.

Beavers are water-loving animals, and if the stream on the banks of which they live is shallow

FIG. 61.—Beavers.

or liable to dry up, a colony always constructs a dam so as to secure a broad, deep, quiet pool.

To make the dam they gnaw down trees, often as much as ten inches in thickness, eat off the bark, and cut the trunk into logs. These logs they convey

to the place where they are building. If the ground is smooth and the distance not great they roll the logs, but frequently they cut canals or water-ways from their pool to the trees, and so move the logs more easily.

They pile the logs together, filling up spaces with brushwood and clayey earth trampled hard down, so as to make an almost solid wall, which only allows water to trickle gradually through.

We read of one dam three-quarters of a mile in length, and of this two-thirds had been made entirely by the beavers. The rest was natural bank which they had raised and strengthened with logs and stones.

If the dam be broken the beavers immediately repair it. One dam was repeatedly cut through because it made a railway embankment unsafe. The beavers built it up again fifteen times, but then gave in and abandoned the place.

The homes of the beavers are very interesting. Sometimes they are mere burrows in the bank with the opening under water, but more frequently the burrow has an oven-shaped structure of wood and earth above it. The "lodge," as it is called, is very comfortable, and is strong enough to keep out beasts of prey. As many as twelve beavers may live in one lodge, for there are young—usually four—born each year, and they stay three years with

their parents. When the lodge gets uncomfortably crowded the young ones move off and construct new homes for themselves.

Many of the beasts of prey, as we have already seen, associate in packs, the better to secure food for the whole pack.

The larger grass-eating animals, too, live in troops or herds under an experienced leader, and unite their forces to defend themselves against a common enemy; this ensures greater safety for the weaker ones and the young; and it is said that if a herd of wild buffaloes be attacked by a tiger, the males will advance slightly towards it, the females and young standing in comparative safety behind them.

Brehm tells a wonderful story of the heroic rescue of a young monkey by the leader of its troop. The naturalist and his followers, accompanied by several dogs, were making their way through a deep rocky valley when the dogs suddenly startled a troop of large baboons, or dog-like monkeys. The females and young took to flight, and were soon safely concealed among the rocks. The males held their ground, growling and beating with their hands, but slowly retreating all the time towards the steep sides of the valley, and soon they too sprang into safety.

But one poor little baby-monkey, not more than

six months old, had been left behind unnoticed. It managed to clamber to the top of a rock out of reach of the dogs, and stood there, crying piteously. The dogs placed themselves so as to cut off its retreat, and the naturalist hoped to be able to

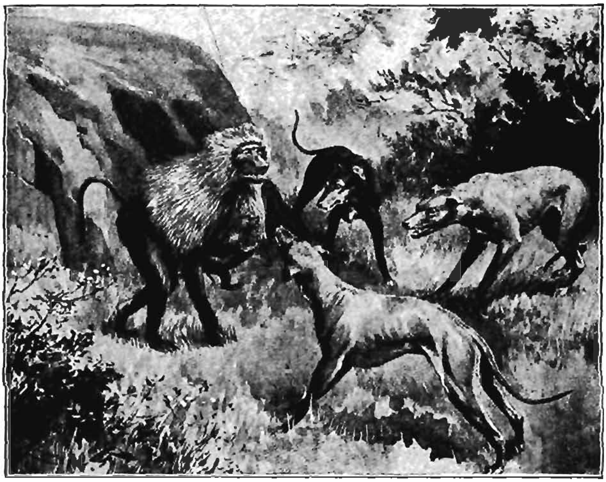


FIG. 62.—Hamadryas Baboon rescuing young Baboon.

secure it. But he did not succeed, for the troop had caught sight of the little one.

"Proudly and with dignity, without hurrying in the least or paying the smallest heed to us, an old male stepped down from the security of the rocks towards the hard-pressed little one, walked towards the dogs without betraying the slightest fear, held them in check with gestures, glances, and quite

intelligible sounds, slowly climbed the rock, picked up the baby-monkey and retreated with it before we could reach the spot, and without the obviously disconcerted dogs making the smallest effort to prevent him."

Among birds also we find many different degrees of association. At the breeding season a great many birds of one kind make their nests close together. Some kinds do so, apparently, simply because the site is a suitable one, for they remain suspicious and unfriendly towards their neighbours, and the two parent birds never leave the nest at the same time. "If they have been disturbed by a common enemy they fly back to the nest as quickly as possible to protect it from others of their own species." This is true of the gulls, and of the penguins, and some others.

Others, again, nest just as close together and live in entire harmony, but each pair keeps to its own nest. The Republican Birds of South Africa go a good deal farther, for they build a common roof under which several hundred nests are closely packed together. The roof is large enough to cover the whole branch of a tree, and as new nests are built under it each year the whole structure grows so heavy that the branch is sometimes broken by its weight.

The roof is made of grasses closely woven

together, and it slopes like the roof of a cottage, so that water rolls off it and the nests are kept dry. It also serves to protect the nests from snakes, which would eat the eggs.

Photo—T. A. Metcalfe.
FIG. 63.—Chaffinch and young ones.

Some birds, especially the crane and the parrot, live in organised bands under experienced leaders. Before going out on a foraging expedition they send out first a single scout, then a party of scouts, to survey the chosen feeding-ground, and only after that does the whole company venture forth to feed.

They are very difficult to surprise, and they seldom fall victim to any enemies except man.

Our common rooks also live in permanent societies, which do not break up even at the breeding season. They set sentinels in the trees when they feed, and when they take their noonday

FIG. 64.—Rookery.

rest. These sentinels watch the whole neighbourhood, and give cries of alarm when danger threatens. If a bird of prey comes in sight the sentinels and a few others rise and give chase, but the main body is not disturbed. An unarmed man, or even, it is said, a man with a stick, excites very little attention, but a gun is immediately recognised; loud cries are uttered and the whole band takes flight to the nearest wood.

When nests are being built it sometimes happens that a young and inexperienced pair, tired of carrying sticks from a distance, steal some of the

FIG. 65.—Group of Herons seen at Lochiel.
Ben Nevis in the distance.
(From Mrs. H. Blackburn's *Birds from Nature.*)

sticks brought by their neighbours. But punishment soon falls on them, for not only those they have robbed but a number more swoop down on

the offenders' nest and pull it to pieces before their eyes! Their social life, therefore, seems to have developed in them "a certain rough sense of justice."

It has also developed affection, not between parents and young alone, but apparently between all the members of a community. If one of them is wounded or taken captive the rest will fly round and round as if trying to succour him, all the time showing signs of great distress.

Not only do the sociable birds live at peace with one another; they live in perfect harmony close to other species, and all of them protect each other mutually by their numbers. A Russian naturalist gives us an interesting picture of an inland lake in Siberia which he visited. Myriads of birds of more than twenty species lived on the lake. Plovers and sandcoursers ran about the shore, a duck rocked on every wave, "the air was filled with gulls and terns, as with snowflakes on a winter day."

"And here are the robbers—the strongest, the most cunning ones, those 'ideally organised for robbery.' And you hear their hungry, angry, dismal cries as for hours in succession they watch the opportunity of snatching from this mass of living beings one single, unprotected individual. But, as soon as they approach, their presence is signalled by dozens of voluntary sentries, and hundreds of gulls and terns chase the robber.

Maddened by hunger, the robber soon abandons his usual precautions: he suddenly dashes into the living mass; but attacked from all sides he is again compelled to retreat. In sheer despair he falls upon the wild ducks; but these intelligent social birds rapidly gather in a flock, and fly away if the robber is an erne; they plunge into the lake if it is a falcon; or they raise a cloud of dust and bewilder the assailant if it is a kite. And while life continues to swarm on the lake, the robber flies away with cries of anger, and looks out for carrion, or for a young bird or a field-mouse not yet used to obey in time the warnings of its comrades." "In the face of an exuberant life, the ideally armed robber must be satisfied with the off-fall of that life."

CHAPTER XIII

SOCIAL INSECTS

In the last chapter, the best of all illustrations of social life among animals—the life of the social insects, ants, bees, and wasps — was purposely omitted, because it is so important that it requires more detailed discussion.

The termites or "white ants" of South Africa, which we mentioned in an earlier chapter, are also

social insects—that is, insects living in a common home, in which each performs certain work, not for its own benefit alone, but for the good of the whole community. But the termites are far away, so we shall confine ourselves to the insects we all know and can observe for ourselves.

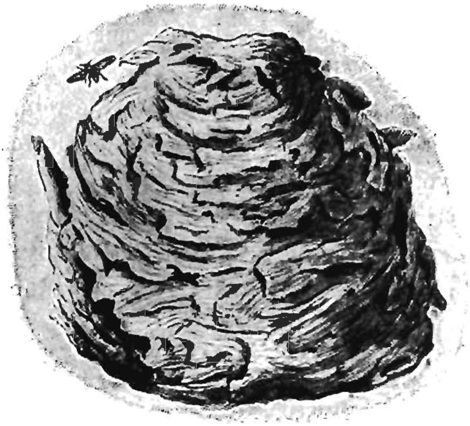


FIG. 66.—Hornet's Nest.

We may reverse the usual order, and begin with an outline of the season's work in a wasp's nest. Some of us, I suppose, have found an empty nest, either of the hornet or of its cousin, the common wasp. We have seen the oval grey mass hanging by a short stalk, have opened it perhaps, and have found within three or four combs of the same papery material. But probably it has never

occurred to us to study such a nest in the life-time of its inmates, for the very words "hornet's nest" suggest getting out of the way as soon as possible.

The young hornet-mother, who has passed the winter hidden alone in a hole, emerges late in April

FIG. 67.—Hornet (nat. size).

or early in May, and seeks out a suitable spot for her nest. This may be under the eaves of a house, or occasionally in a hole in the ground, but is most often in the cavity of a hollow tree. The spot chosen, the hornet flies away for her first load of material. She cuts off a portion of the bark of a tree—the ash being her particular favourite—chews it with her powerful jaws, mixes it with saliva, and

N

kneads it into a fairly large pellet, which she carries home between her front legs, and pressed against her body. Then, holding it firmly between the "knee-joints" of her antennæ, she tears off strips with her jaws as quickly, we are told, as if she was unwinding a ball. After moistening these strips she fixes them in the desired position.

At first her work is comparatively simple, and it proceeds rapidly. But things soon become more complicated. When the stalk and a small piece of the top of the outer envelope are ready, the cells have to be made, and the methodical little hornet adds a piece to the envelope and works at her first comb of cells turn about.

As soon as the first cells are ready, the mother hornet begins to lay her eggs. She inspects each cell, then drops into it an egg, which adheres to the floor of the cell by means of a sticky substance on its lower end.

In a few days, varying in number according to the season, the larvæ emerge from the egg, and the busy mother has now to divide her attention between continuing the walls of her house, adding new cells, laying eggs in these, enlarging the old ones to keep pace with the rapid growth of the inmates, and procuring food for the hungry young. From many of her journeys she now brings home, instead of a ball of wood, a little food-pellet, which she makes by

catching an insect or beetle of some sort, stripping it of its wings, legs, and head, and chewing up the softer parts of its body. This dainty she distributes impartially among the larvæ.

When the larva has attained its full size, it spins a silken covering over its cell; then it casts its last larval skin, and enters on its resting stage. This lasts from thirteen to sixteen days, and then the insect breaks open the top of its cell with its mandibles or jaws, and comes forth a worker wasp. As soon as two or three workers are ready to help her, the mother gives up foraging, and egg-laying proceeds more rapidly. The nest is soon finished, and the life of the colony is at its height. But it does not last long. The wasps have not learned to store up food for the cold season, and with the end of the summer all perish except the future mothers, who are already safely hidden away in holes to sleep through the winter.

The mother humble-bee also sleeps through the winter, and when spring comes she sets herself to found a new colony, doing the whole of the work herself, just as the mother wasp does, until the first batch of eggs is hatched and the workers are ready to help her. In this case, too, the life of the nest, as a whole, comes to an end in autumn, and only the future mothers survive the winter.

Among the hive bees, however, matters are some-

what different. Many of the worker bees, as well as the "queen," who is the mother of the whole hive, live through the cold weather. In spring they all rouse up from the somewhat sleepy condition in which they have passed the cold weather, and set to work to clean the hive, and get it in order for the busy summer. The queen at once resumes the egg-laying, which is her sole business in life. Some of the workers devote themselves to the care of the little white grubs, which emerge in a few days from the egg, and to the other domestic duties. These consist in attending on and feeding the queen, and in building and repairing the combs, for which the wax is secreted by special glands opening on the under surface of the body.

Other workers, usually the older and stronger ones, have the duty of providing food for the whole colony. To do this, they toil hard from early morning, sipping the nectar from flower after flower, and collecting the pollen or golden dust, which is kneaded into a little ball and packed into the "pollen-basket," a little bristle-fringed hollow on the hind leg.

But how is the nectar carried back to the hive?

The tongue of the bee when at rest lies within an ensheathing tube. To get at the nectar the tongue is protruded beyond the sheath, and pushed down the flower-tube. The nectar is sucked up

through the hollow tube, and passes into the mouth, and thence into the "honey-bag." This is an enlargement corresponding to the "crop" in birds. A small portion of the liquid passes on into the digestive tract to supply the bee's own wants, but the greater part is carried home and deposited in the storing cells for general use. By this time, however, it has undergone a change, and is no longer nectar but honey. The indoor workers draw on these stores to feed the young ones, as well as for their own needs. The ordinary grubs, which will become workers and drones, are fed with pollen previously masticated by the workers, but the future queens receive a more nutritious "royal jelly" from the mouths of their attendants.

When the hive becomes uncomfortably crowded the old queen leaves it with a "swarm" and founds a new colony. The young queens, which have so far been kept prisoners in their cells because the jealous old queen would tolerate no rival, are now set free, and they immediately fight among themselves! The victor flies away with an attendant crowd of drones, but soon returns to the hive to take up her position as queen and mother.

The worker bee's industrious life is not a long one —only about six weeks in the busiest season. But new workers are always being hatched, and the later brood live through the winter.

The drones, who do no work, feed from the common store throughout the summer. But in autumn, when food is beginning to get scarce, these idle members of the community are driven out and left to perish, or even bitten or stung to death by the ruthless workers.

We need not go into detail with regard to life in an ant's nest, for it has much in common with that in a bee-hive. The labours are divided in the same way, the young receive the same care. We can make sure of this last point for ourselves by turning over almost any flat stone on a summer day. Every ant at once picks up a little oblong white body, and scurries away with it to a place of safety. These are not ant's eggs as they are frequently called, they are the resting pupæ, within the cocoons which they themselves have spun.

We can see for ourselves, too, the long lines of ants going to and from a nest, the returning ones bearing home precious stores. And if we experiment a little with them, we may see how one ant calls others to its aid when it has found a caterpillar or other booty too big for it to carry alone. It is interesting to watch them trying various devices until they have hit upon the best way of tackling the unwieldy object.

The life of each ant is bound up with that of the whole colony to which it belongs. The three

classes, queens, drones, and workers, have each their own place to fill, and if any one of them were wholly cut off the whole colony would perish. But the relations between ants and other living things are even more remarkable.

In South America there are species known as leaf-cutting ants, which send out large foraging

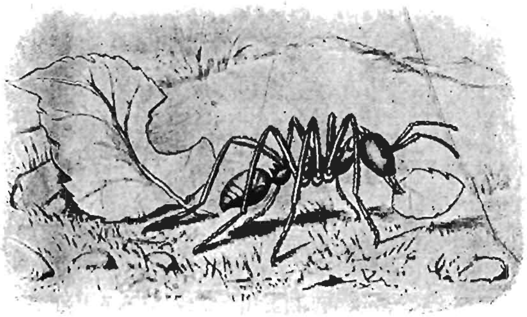


FIG. 68 —Leaf-cutting Ant (magnified).

parties, each of which cuts a circle about the size of a sixpenny piece out of a leaf, and bears it back to the nest. Unfortunately for man it is very often cultivated plants that are selected for this treatment. The ants do not eat these leaves, and for a long time no one understood what they did with them. It has now been found out that special workers work the leaves into a sort of pulp, and store them in the galleries of the nest, where they

soon become covered with an abundant growth of a particular fungus of which the ants are extremely fond. If the ants forsake their nest for any reason they carry the pulp with them, but they leave behind any that has already exhausted its fungus-growing powers. Thus they cut and bring home and prepare the leaves on which to grow their favourite food, apparently as deliberately as we prepare our mushroom-beds!

Let us follow one more thread of the web of life in this connection. A great many plants have animal guests, that is, animals which live on and receive some benefit from the plant, probably doing it some service in return. Many plants have developed little shelters, which are used as homes by their animal guests. Thus the partnership is a constant one, and if these shelters have really arisen in relation to the guests it must be for the benefit of the plant in some way, since no living creature develops structures which are not of use to itself in the struggle for existence.

The animals, ants, mites, or whatever they may be, receive shelter and abundant food from the plant. But what does the plant get out of the partnership? Probably in most cases freedom from injurious insects or destructive fungi.

Certain trees shelter a whole army of ants within little openings into the hollow trunk, and

if the tree be shaken these immediately rush out intent on combat. When a procession of leaf-cutting ants appears and begins to climb the tree the resident ants rush out upon them; the two armies fight furiously and the invaders are usually driven off. The ant-guests apparently act as a bodyguard to the tree which affords them shelter and food.

In North America there are "agricultural ants" which keep a space round their nests clear of all plants, except a few kinds which supply them with edible seeds. These they tend carefully, and reap the crop in due season!

This habit does not occur in any of our British species, but some of them keep domesticated animals. The aphides, or plant lice, which infest our rose-bushes and other plants, secrete a sweet, sticky fluid, known as honey-dew, which is much appreciated by the ants. Some species of ants simply climb the bushes to procure the fluid, but others have learnt to secure a constant supply by taking aphides, of a kind which lives on roots, into their nests. There they cherish and feed them carefully, make tunnels to the surface so that the mature aphides may fly forth when the time comes, collect them again, carry them back to the nest, and look after the eggs with the same minute care which they give to their own.

Many other animals are found living in the ants'

nests, some of them as parasites, some of them apparently simply as pets; for the ants feed them, and take them with them if they change their abode, though they receive no benefit from them so far as we can see.

There are ants, too, which keep "slaves." They

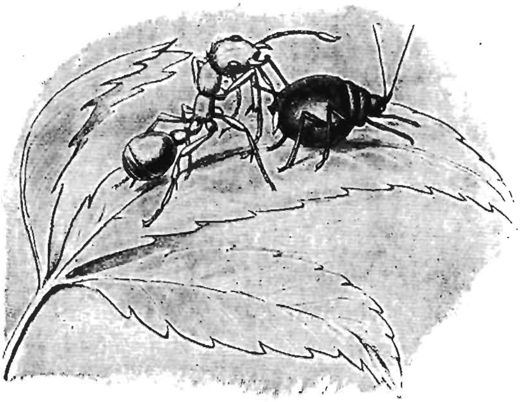


FIG. 69.—Ant and Aphis.

make a raid on the nest of another and smaller species and carry off many pupæ to their own nest, where the workers emerge. These workers immediately take their share in all the labours of the colony, and are always kindly treated by their masters.

But this high-handed stealing of their neighbours' children has brought its own punishment in one

case at least. The Amazon ants have become so dependent on their slaves that they have quite forgotten not only how to work but also how to feed. They simply receive the food that is put into their mouths by the slaves, and without the ministrations of these willing helpers they would starve in the midst of plenty. Thus the slaves have become virtually the masters.

CHAPTER XIV

INTER-RELATIONS AMONG PLANTS

In all that we have said hitherto, the place of plants in the web of life has been considered only in so far that the plants form the food of many animals directly, and indirectly of all animals and of man himself.

But if we consider more carefully the *life* of plants we shall find that the plants are linked to one another, and to the animal kingdom, in many different ways.

For plants, as well as animals, are living creatures. "They move though without changing their place; they feel though without nerves; they feed though without a stomach; they live without knowing it; they die without caring."

Plants have the same great need as other living creatures—food sufficient for their own growth and to lay up as a store for the seedlings, which are their children. But this need is supplied in quite a different way. While animals feed upon plants and on other animals, plants feed at a much lower level. They take in water and salts through their roots from the soil, and carbonic acid gas from the air by means of their leaves. These comparatively simple foods, with the help of the sunlight, are worked up within the green leaves into starch and sugar, and still more complex substances called proteids, such as the gluten, for the sake of which we eat bread.

If plants thus get all that they need from the earth and the air, how are they dependent on, or linked with one another?

We can easily answer this question if we look for a while at a spot where the soil is rich and the climate favourable, and see how crowded it is with plants of all kinds. There is competition for the available food-supply among plants as well as among animals, and this competition is all the keener because plants cannot move from place to place, and because, unlike animals, they all require, in a general way, the same kind of food.

If we leave the plants in a bed or border in our gardens to themselves for a few years, we shall see

that the more vigorous and rapid growers will, in time, crowd the more delicate plants out of existence altogether. The common elder, for instance, will push its branches in and out and above the other shrubs, overshadowing them and taking up so much more than its share of moisture from the soil, that even the hardy rhododendrons droop and give way in the struggle.

In the fields and woods, too, there is a constant struggle for space and light. But here again Nature has many ways of helping her children. Let us think of some of these.

Many plants have long and narrow leaves like the grasses; others have compound leaves made up of many little leaflets; and others have leaves the edges of which are deeply indented. In these and in other ways a large surface of leaf is exposed to the air. We may sometimes see plants the lower leaves of which are much indented, while those on the upper part of the same stem are simple, because they are more favourably situated for absorbing what they need from the air than those which are more shaded and crowded by other plants. Water-plants, too, which make use of the carbonic acid gas dissolved in water, frequently have their leaves much cut up. The pretty little white water-buttercup, which covers many of our ponds in the early months, shows the two kinds

of leaves well. Those under the water are almost thread-like, while those that reach the surface are simple.

Another of the ways in which some plants solve the problem of reaching air and light is by *climbing or twining* round sturdier plants; some of these climbers, like the common cleavers or the brambles, simply scramble in and out among the other plants of a hedgerow, fixing themselves here and there by hooklets.

Others, such as the ivy, throw out rootlets from their stems, and these attach themselves to a tree or an old wall, or any other available support.

Others, again, like the traveller's joy or wild clematis, twine their leaves round the stems of other plants; while some are more highly developed still, and have special climbing organs known as tendrils. These move slowly round and round until they find a support, and then twine themselves firmly about it. We can study tendrils well in our garden sweet-peas.

But other plants have gone further than this. They have lost all connection with the soil, and live entirely on the shoulders of their neighbours, yet without being indebted to them for anything more than their support. These perching plants, sparsely represented in our country and other temperate lands by some mosses, lichens, and fungi, are

a conspicuous feature of tropical forests, where they often bear gorgeous blossoms. They are attached by long stems or root-suckers to the trunk of a tree, but they have usually aerial roots through which they take in moisture from the air, and they manufacture their own food-stuffs within their green leaves, just as other plants do.

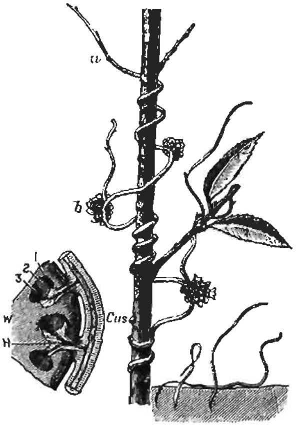


FIG. 70.—Dodder on a twig of willow. *a*, reduced leaves; *b*, flowers. On the left side is a piece of the stem of the host-plant cut across. This shows how the suckers of the dodder enter the host-plant. *W*, willow stem; *H*, dodder sucker; 1, 2, 3, roots of dodder.

It was an easy step from this perching habit to taking a part of the necessary nourishment from the supporting tree. The familiar mistletoe, with which we decorate our rooms at Christmas, is a good example of this half-thievish way of living. A bird drops the seed of a mistletoe on a branch of an apple, a poplar, or an oak tree. The little seedling soon appears and sends its sucking rootlets into the young wood of the branch, drawing moisture through them from its host. Year by year the roots spread more widely through the wood, the

stem grows thicker, fresh stems may arise, and the mistletoe grows large and strong, and bears bright green leaves and glistening white berries.

The mistletoe and others of its class still get the greater part of their living by their own industry, but there are plants which are entirely parasitic, and are so wholly dependent on rifling the stores of others that they die if they do not find a host. These plants have no green colouring and so take nothing from the air, but their roots penetrate into the stems of the plant to which they have attached themselves, and draw from it, not the water and salts it has absorbed from the soil, but the precious food-stuffs it has manufactured in its leaves.

Though it is true of the great majority of plants that they take up the whole of their food from the air and from the soil, it is interesting that there are numbers which supplement this diet in a strange way—by absorbing the juices of dead insects and small animals. These insectivorous plants have many different kinds of adaptations for keeping up the supply of insects.

Very well known are the beautiful pitcher-plants of the tropics, but, as we can only see these in hot-houses we shall confine ourselves to three of the insectivorous plants of our own country.

In many of our marshy pools there grows a plant known as the bladderwort. Most of the plant is

under water, so it is not easily seen except for a few weeks in summer when it bears golden blossoms. It has no roots, but has long stems bearing thread-like leaves. Among these leaves there are many little stalked hollow bladders with a very small opening at the apex. This opening is surrounded by a fringe of hairs, and is guarded by a valve-like lid, which opens only inwards and then springs back into place. Many minute crustaceans find their way, either by chance or from curiosity, into these curious little traps. They are unable to get out again and soon die, and the juices of their bodies are absorbed by cells on the bladder walls.

FIG. 71.—Pitcher-leaf with part removed to show the fluid inside (*F*).

Many of us must have seen the butterwort with its rosette of bright green leaves and little purple flowers. It is common in marshy ground. Its leaves are sticky, and midges and other small insects get caught on them, and as they struggle the edges of the leaves curl over, and more and more of the sticky slime is poured out, till the insects are drowned and finally dissolved in it.

Another insectivorous plant is the sundew, whose little rosettes of bright red leaves covered

with hairs may be seen in many marshy places. The hairs are often tipped with drops of fluid which sparkle brightly in the sun, and it is to this that the plant owes its pretty name. These seeming dewdrops are really a sticky slime which catches any little insect that settles on the leaf. As soon as an insect alights, the little hairs or tentacles begin to curve slowly towards it and pour out —and there are about two hundred on a single leaf—the sticky slime, which is also a digestive fluid.

FIG. 72.—Sundew.

Darwin and one of his sons made a beautiful series of experiments with the sundew, growing it and watching it for years to find out whether it really *digested* the insects caught on its leaves, and if it did, whether this food was of any advantage to the plant. They supplied some of the plants with little pieces of egg and of beef, and put similar pieces at the same time on wet moss. Those on the sundew leaves were rapidly dissolved, while those on the moss simply decayed in the ordinary way. Plants were also grown in plates divided across, those in one division only being supplied with

animal food. It was found after a time that the insect-fed plants throve better, and especially that *they gave rise to a much greater number of seeds* than those which had only what they could get from the air and the soil.

There is one other relation between plants and animals of which we must speak for a little —*the relation between flowers and their insect* visitors.

More than a hundred years ago a German botanist named Christian Conrad Sprengel used to wander about the country watching the flowers, and *the bees and butterflies which sip their overflowing* sweetness. He soon began to understand that this was not a mere chance association, that the bee, flying from flower to flower to sip honey and gather pollen, had some special meaning for the plant. So he went on patiently and lovingly watching until he found out what the meaning was. Then he published what he had learnt in a book with the triumphant title, *The Secret of Nature Discovered.*

But the book did not attract much attention. People were not thinking about that sort of thing at the time, and for seventy years Sprengel's work lay neglected, until Darwin showed its importance and continued it farther.

The "secret" is now well known. The ovules or possible seeds in the seed-box of a plant cannot

become real seeds—able to give rise to seedlings—unless they are first fertilised by the pollen or golden dust made by the stamens. And though it may not be absolutely essential, it is greatly to a flower's advantage that its seeds should be fertilised by pollen from another flower, and not from itself. And this is what happens in honey-flowers; for the bees as they work within the flower become covered with the golden dust. They brush off some of it, and pack it carefully into a little receptacle, the "pollen-basket," on the hind leg, so as to carry it back to the hive for "bee-bread." But a great deal remains about their bodies, and this is rubbed off on the pistils of the next flower they visit. From the top of the pistil the pollen-grains grow down into the seed-box and fertilise the ovules, within each of which an embryo plant begins to grow.

We can now understand Darwin's famous illustration of the web of life—that the clover crop about a village depends on the number of cats in the village.

The pollen of clover is carried from flower to flower, all unconsciously, by the humble-bees which visit them. But the great enemies of the humble-bees are the field-mice, which destroy the young bees in the combs. The enemy of mice is the cat, so the more cats the fewer mice, the fewer mice

the more humble-bees, the more humble-bees the better next year's clover crop.

The plant's work is not over with the ripening of the seeds. These have still to be scattered abroad, so that they may have the best chance of germinating where there is space for the seedlings to grow. Many seeds are borne by the wind, but many more are carried by the agency of animals.

"First come the birds, for which are provided succulent, pulpy coverings, which may be swallowed and thus carried far away without injury. The bird eats the fruit here and drops the seed many miles away, possibly in some place where some of them may find room to grow. . . . At nights bats fly far and bring in the harder fruits, the coverings of which they gnaw, leaving the seeds to drop anywhere on the way or to form a litter about their homes. . . . In the forest also the monkeys gather nuts which they scatter in every direction."

With the scattering of the seeds the work of the plant or tree is at an end for the season, and it is ready for the rest of winter. The leaves prepare to fall, but first they yield up to the parent tree all the valuable food-stuffs stored up in them. In doing this they lose their green colour and take on tints of gleaming red and gold. They fall, but even then, the story is not all told. They form a warm covering on the cold ground, and become "the

cradle-clothes of next years seedlings"; the earthworms grip them and drag them into their burrows; the ever-present bacteria feed on them and break them down into their simplest elements, so that they become part of the soil, ready to enter once more into the life of plants when growth begins again in spring.

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